THE ENGINEER

Engineering, Marine and Welding Exhibition at Olympia

Descriptive Supplement

THE nineteenth Engineering, Marine and Welding Exhibition, which this year incorporates the Chemical Plant Exhibition, was opened at Olympia, London, yesterday, and will be open daily until September 17th. In it more than 500 leading manufacturers are showing representative mechanical, marine, electrical, chemical and welding equipment. Coming, as it does, at the time of year when the engineering and allied institutions are about to start their autumn meetings, this exhibition provides a good opportunity for inspecting the latest plant developments, some of which will undoubtedly become the subject of discussion in future sessions. For this reason the organisers go to much trouble to assist institutions to make this a social occasion and to arrange meetings at Olympia, the scope of the exhibits being such that subjects of interest can be found for all the engineering institutions.

Although this social side of the exhibition is of interest, it must not by any means be considered as catering for this aspect alone for, as potential buyers will find, the representatives of the various manufacturers are keen demonstrators, and as experts in their subjects have much to show. The firms themselves have taken every opportunity to arrange their products in such a way that they can be inspected with ease and their merits, points of design and applications discussed with specialists of no mean order. Much of the plant made by a number of firms is too large and of such a complicated nature that it cannot, by reason of size alone, be exhibited. In most of these cases the best possible use has been made of models, graphic diagrams, films and photographs of component units to show the methods of construction and operation.

As for the exhibits themselves, their variety is so wide that we cannot hope to present in our pages more than a general impression of what there is to be seen. In this Supplement and in articles that will appear in subsequent issues of THE ENGINEER we have endeavoured to select a range of representative exhibits to show the wide industrial field covered, and draw particular attention to new developments and noteworthy plant.

Hancock and Co. (Engineers), Ltd.

A new profile flame cutting machine, which is exhibited by Hancock and Co. (Engineers), Ltd., Progress Way, Croydon, whilst retaining the principles of the familiar "U" arm machines made by the firm for the past twenty-five years, is of completely different design and construction in most respects. The new machine, known as the "Hancomaster," is exhibited for the first time at Olympia, and its general design can be seen in the illustration Fig. 1.

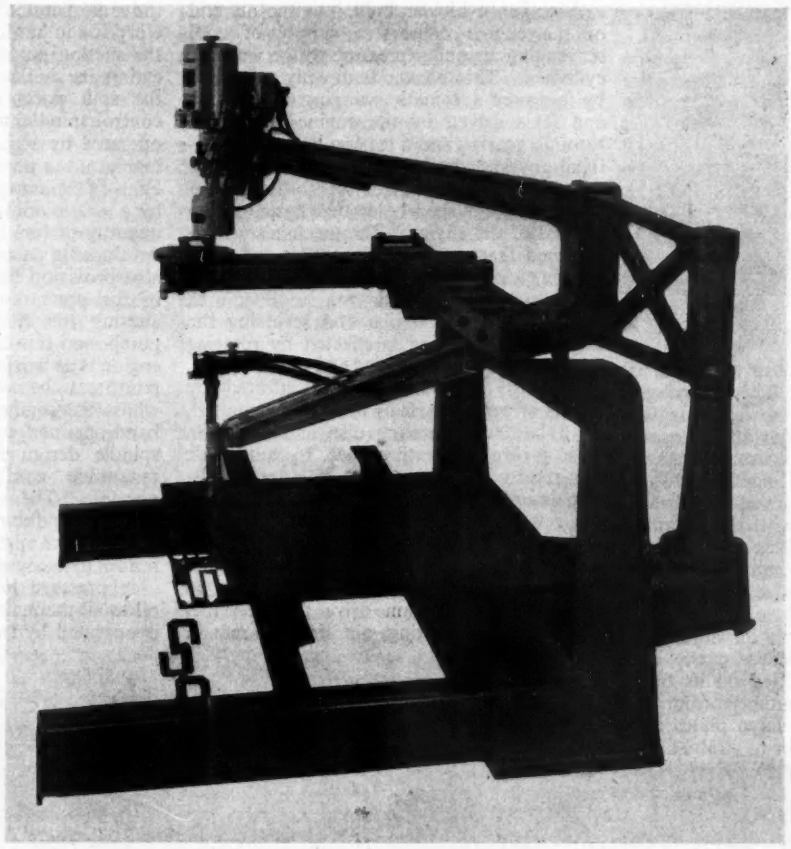

Fig. 1—Profile Flame Cutting Machine—Hancock

In this machine the tracing board has been replaced by a movable template carrier supported on a rigid built-up beam extending across the width of the machine at the rear of the cutting area. The carrier is mounted on ball bearing rollers and it can be moved freely along the supporting beam and clamped in any required position. A forward projecting arm on the carrier box is built up of channel section and has a slot along the full length of its upper surface. This arm extends across the full width of the cutting area and can be hinged back when it is required to load heavy plate on to the machine. Lightweight plates can be slid on to the machine supports, the open design of the front and low loading position facilitating the use of mechanical trucks for feeding the machine.

The carrier arm is designed to support either a circular slotted faceplate, as shown in the illustration, for supporting the template, or it can take a circular tracing board for cutting circles or a straight guide for line cutting. The template or cutting attachments can be moved transversely along the carrier arm slot or the carrier arm can be moved along its beam to any required position over the cutting area. In cases where large templates cannot conveniently be supported on the movable template arm, two auxiliary arms can be clamped to the beam to provide support at the extremities of the cutting area. These auxiliary arms are also used in cases where a large tracing table is required for hand guiding round a drawing or for mounting very large templates of plywood or aluminium sheet.

The illustration shows the new machine in use with a steel template and fitted with one of the makers' magnetic drive tracer heads. By moving the template carrier between operations quantities of small parts can be cut out of a single large plate without need for resetting the template or moving the plate. This "U.T.4" tracer head has all its controls conveniently grouped round the head, and with it there is a choice of five drives suitable for templates of steel, aluminium sheet, plywood, or for hand guiding round a drawing.

Another new machine made by this firm is the "Hancoplane" flame planer for plate edge preparation. It is built to cut simultaneously all four sides of plates up to 15ft by 50ft, with a deviation from the straight on any side of less than $\frac{1}{16}$in. The edge preparations which can be obtained with the machine include a vertical cut, a single bevel, a single bevel and root face, a double bevel and a double bevel and root face. The angle of the

bevels can be up to 45 deg., and a standard machine will prepare plates up to 2in thick. Attachments can be provided for preparing plates up to 5in thick, if required. A compound cutting head used on this machine is illustrated in Fig. 2. Each burner in this unit is coupled to a common mixing chamber, the two outer burners being adjustable for angularity and all three burners being individually adjustable for height.

The machine consists essentially of two longitudinal high-tensile steel rails, between which the plate is positioned. At each end of the machine, and adjustable along the rails in accordance with the length of the work, is

Fig. 2—Flame Planer Cutting Head—Hancock

a gantry supporting a carriage on which is mounted a cutting head. These carriage-mounted heads are used for preparing the plate ends. The plate sides are prepared by two carriage-mounted heads on a gantry which runs along the main longitudinal rails of the machine. The carriages of these heads are spaced in accordance with the required plate width, and cutting takes place as the complete gantry assembly traverses along the plate.

If desired, one or both of the ending carriages can be fitted with an adjustable cross beam for making oblique cuts. The main gantry can also be fitted on its front face with a bar carrying a number of burners when it is required to cut large plates into strips or to make any number of straight cuts simultaneously.

Crossley Brothers, Ltd.

Five two-stroke engines, representative of units made for marine, locomotive and stationary installations are shown on one stand of Crossley Brothers, Ltd., Manchester, and on another stand a number of models have been arranged to illustrate some other engines built by this firm. One of the marine diesel engines, a six-cylinder, 1100 b.h.p., 320 r.p.m. unit having a bore of 14½in and a stroke of 19in is illustrated in Fig. 3.

This engine is mounted on a base of rigid girder design which carries the crankshaft, and bolted to this case is the monobloc casting of the crankcase. The cylinder block, secured to the crankcase by through bolts, has detachable liners of close-grained cast iron. Each of the water-cooled cylinder heads is fitted with a fuel sprayer, an air starter valve and a relief valve. The connecting-rods are machined from steel stampings

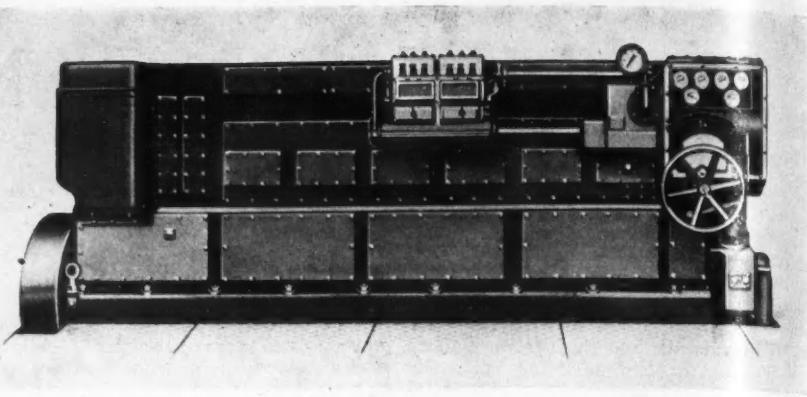

Fig. 3—Six-Cylinder, 1100 h.p. Marine Oil Engine—Crossley

and each is bored throughout its length to deliver a supply of oil under pressure to the gudgeon-pin bearing and the oil-cooled piston. All of the pistons are lead-bronze banded and lubricating oil from the connecting-rod circulates through a chamber on the underside of the crown and piston-ring belt.

A scavenge blower built into the aft end of the engine delivers a supply of cool scavenging air under pressure to the working cylinders. This blower is directly reversible by means of automatic swinging door valves and it is driven by the engine crankshaft through gearing and a torsion bar. A centrifugal governor built into the engine controls the speed from one-quarter to full speed and throughout the whole range has complete control of the engine. The mechanism is so designed that should the propeller come out of the water the governor maintains the engine speed constant.

Starting of the engine and reversing the direction of rotation is effected by rotating a handwheel at the forward end of the engine.

Starting and reversing are effected by means of compressed air which is distributed, by a hardened rotating disc in association with a bronze seating face, to automatic non-return valves in the cylinder heads. The drive from the engine crankshaft through the reversing mechanism to the fuel pump and starting air distributor consists of a duplex chain and two helical spur gears. A swinging jockey tensioning device is so arranged in the chain drive that the fuel injection and starting air timings remain unchanged as any chain stretch is taken up.

The fuel pumps are arranged in a unit centrally located on the front of the engine, a position which affords the maximum accessibility and enables the fitting of short sprayer pipes. The pump operates entirely upon the port control principle, and in it the cam-operated main fuel pump plungers reciprocate in hardened steel guides and control the suction ports. Control plungers reciprocating in similar detachable guides control the spill ports. Each main plunger and control spindle, a pair for each cylinder, are operated by a single cam, and the governor regulates the position of the control spindle. Each fuel pump can be accurately balanced by a simple adjustment to deliver its correct quantity of fuel to ensure that each cylinder develops its equal share of power. There is also provision by means of eccentric bushes in the pressure-lubricated roller levers for altering the timing of injection for each pump, and this can be carried out whilst the engine is at work, if desired. Any individual pump can be separately cut out of action whilst the engine is running by means of a hand-operated cut-out plunger. The short spindle design fuel sprayers each have a renewable combined spindle guide and nozzle. The differential spring-loaded sprayer spindles open under the action of the fuel pressure applied from the fuel pump and instantaneously close at the end of injection.

A pressure lubricating system supplying oil to all the main moving parts of the engine is operated by two gear pumps. One pump

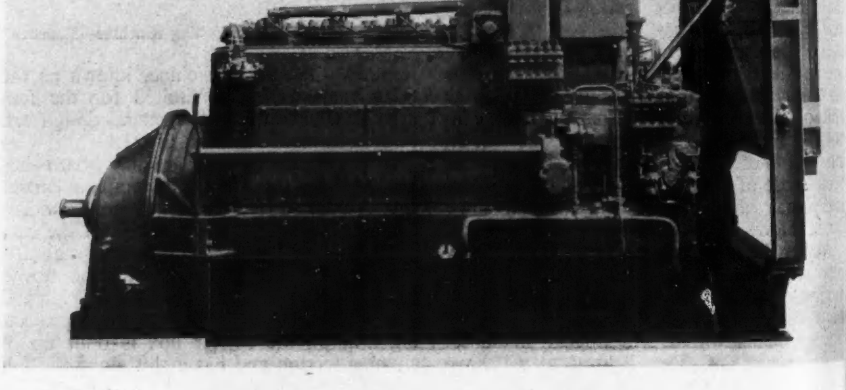

Fig. 4—250 b.h.p. Packaged Power Unit—Crossley

provides the piston cooling and lubricating oil to all parts of the engine and the other transfers the used oil from the engine base back to an external tank for filtering and recirculation. Circulating water pumps of plunger design are driven by an eccentric from the engine crankshaft, and with a two-stage water-cooled air compressor are mounted in an accessible position at the forward part of the unit.

A packaged power unit exhibited is illustrated in Fig. 4. This four-cylinder engine develops 250 b.h.p. at 900 r.p.m., and is a self-contained unit complete with radiator under-base and clutch-operated power take-off.

C. A. Parsons and Co., Ltd.

Many of the exhibits shown by C. A. Parsons and Co., Ltd., Newcastle upon Tyne, emphasise the company's transformer work. Large transformers cannot be shown because of space limitations, and the main exhibits include a model (Fig. 5) of a 120MVA, three-phase, 50 c/s, star-connected auto transformer for use at points of interconnection between the existing 132kV system and the new 275kV system of the British Electricity Authority.

A lower voltage tertiary windings is incorporated in the design, and the common neutral point of the transformer will be solidly earthed. A tapping range of plus and minus 15 per cent in eighteen steps is provided in the main 132kV common winding, the tap changing equipment being arranged for on-load variation. On the 275kV side re-entrant condenser bushings are used to allow a convenient connection to be made to the top of the e.h.v. winding. The transformers are ON/OFB cooled with an ON rating of 60MVA. Four " A " type radiators are provided, fitted with auxiliary equipment which produces forced oil and air circulation, the equipment being automatically controlled by winding temperature indicators. The total weight of the complete unit is approximately 250 tons.

To give some idea of the size of the completed transformer a full-size 275kV re-entrant bushing is exhibited beside the model.

The company's work on generating plant is exemplified by a completely bladed high-pressure turbine shaft (Fig. 7) for a 60MW, 3000 r.p.m., three-cylinder turbo-alternator to operate with high steam conditions. The blading is arranged on a constant mean diameter, necessitating only a single dummy

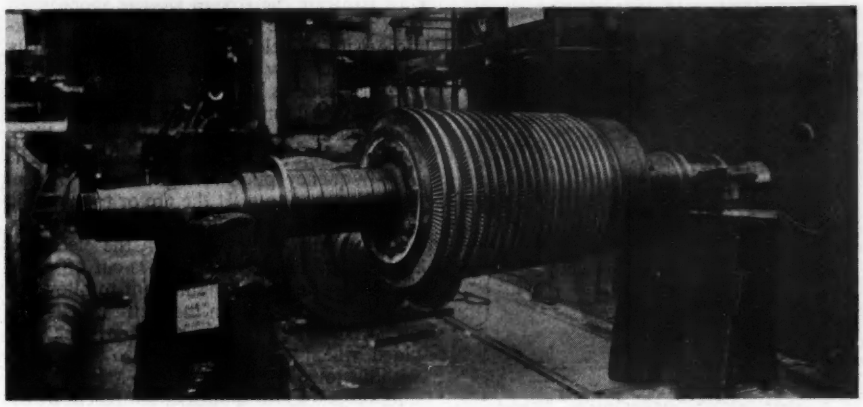

Fig. 7—Bladed Shaft for 60MW, 3-cylinder Turbine—Parsons

to balance the steam thrust on the blades. At the initial end the blades are manufactured with integral roots and shrouds and, for convenience of handling, they are formed into short segments which are serrated along the root portion and secured in serrated grooves in the rotor by side locking strips.

The shrouds have axially projecting portions which are knife-edged and co-operate with the spacing sections of the adjacent row of stator blades to form a seal. Leakage of steam is thus primarily controlled by an axial clearance, which can be set to any desired value with the machine cold and, if desired, adjusted while the machine is running by means of an adjusting gear fitted to the thrust block : this facility is often referred to as " end tightening." A supplementary seal is provided by a radial fin machined integral with the shroud and set at a reasonably fine clearance from the cylinder bore.

Metropolitan-Vickers Electrical Company, Ltd.

On the ground floor stand (Grand Hall) of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17, the exhibits include a model of a 120MVA, 132/275kV transformer with on-load tap changers. This model (Fig. 6) represents, to a scale of ½in to 1ft, one of eight transformers which are being built by the company for the British Electricity Authority. Each equipment is a three-phase star-connected auto transformer with tappings at the 132kV line points covering a range of 30 per cent in eighteen steps. The tappings are connected to three single-phase on-load tap changers (type " H ") of which sixty-nine are in hand for the 275kV system. As previously described in THE ENGINEER, a prototype transformer has been built and its impulse withstand level has been demonstrated to B.E.A. representatives at the company's high-voltage research laboratories.

On the same stand there is an engine-room control desk for a 600 s.h.p. diesel-electric trawler. This is a comprehensive working exhibit, including telegraph receiver, propeller revolutions per minute meter, " ready-for-propulsion " lights, electric alarm signals, change-over switches (engine-room to bridge), &c., erected in conjunction with a section of a ship's deck and a telegraph control desk. The control desk will be installed in a Fisheries Research trawler, which will be the first diesel-electric trawler built in Great Britain and the first in the world to operate at a constant-current system with metadyne control. The equipment being supplied by the company will comprise a 600 s.h.p., 200 r.p.m. propulsion motor, four 150kW, 1400 r.p.m. diesel-driven generators, a 150 h.p. trawl winch operating at 500A, and auxiliary generator sets and motors.

Another exhibit consists of a steam turbine control desk for a cargo vessel of 8000 s.h.p. This desk, which includes gauges, automatic turning gear lever, ahead and astern valves, &c., is for use with one of the 8000 s.h.p. geared steam turbines made by the company for the Blue Funnel cargo ships " Nestor " and " Neleus " (Alfred Holt and Co.). The turbines operate at 600 deg. per square inch gauge, 950 deg. Fah., and this is said to be the first time that such high steam conditions

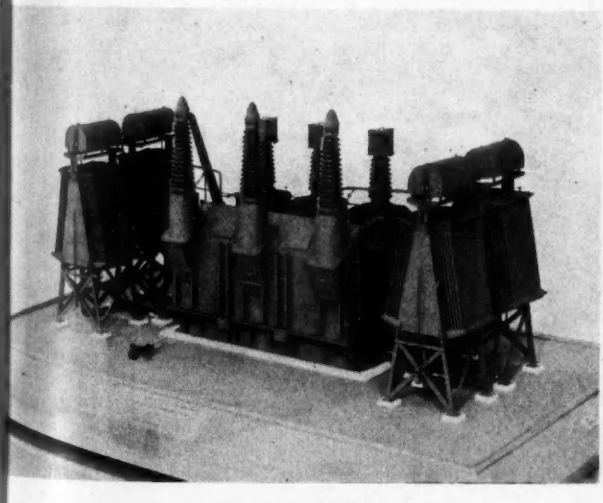

Fig. 5—Model of 120MVA, 132/275kV Transformer—Parsons

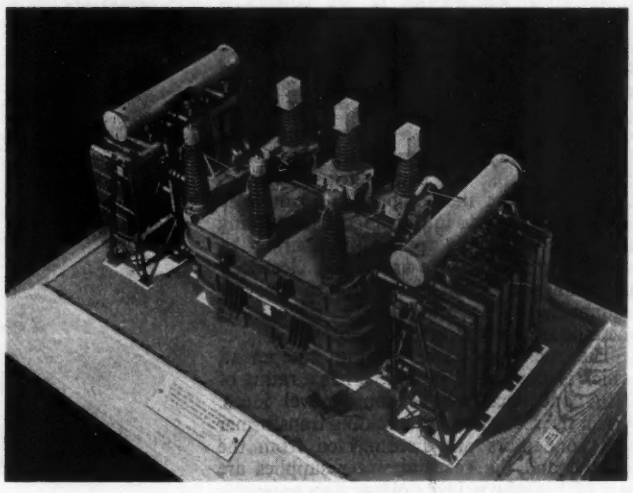

Fig. 6—Model of 120MVA, 132/275kV Transformer—Metropolitan-Vickers

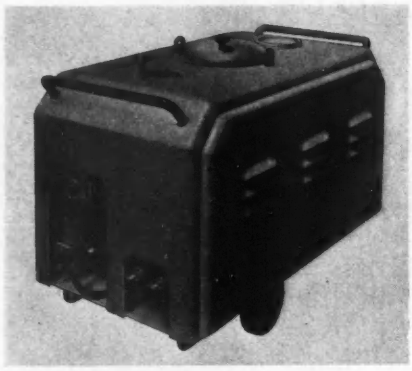

Fig. 8—Inert Arc Welding Equipment—Metropolitan-Vickers

have been employed on merchant ships built in this country. The sets incorporate semi-automatic turning gear, which was developed to enable the turbines to be kept turning during manœuvring with the steam shut off.

On a separate stand on the ground floor of the Empire Hall the same company is showing examples of its equipment for all classes of electric welding, including resistance, automatic arc, inert arc, and atomic hydrogen welding.

The automatic arc welding equipment displayed incorporates a recent design of travel carriage, which enables welding speeds from 3½in to 55in per minute to be obtained. The welding head can be mounted either directly on this carriage or on a projecting slide which can easily be fitted to it. The projecting slide allows the welding head to be moved out a further 18in in front of the carriage, thus allowing the head to be lined up to a number of different weld positions without the necessity of moving the work. Compound adjustment slides can also be fitted to provide the vertical and horizontal adjustments of the welding head that are necessary on many jobs.

The electronically controlled welding head is suitable for a great variety of electrodes without adjustment, and the angular adjustment face plate and variety of mounting positions permit easy positioning for practically any butt or fillet welds in the downhand or horizontal-vertical position. The railed track on which the carriage runs can be supplied in any length built up from standard 6ft or 9ft lengths. The carriage can be locked in any position on the track when required for circumferential welding. The welding head is controlled by an electronic circuit in which the arc voltage is compared with a preselected reference voltage ; the response to any change in arc voltage is practically instantaneous, thus enabling maximum deposition of weld metal to be obtained. The equipment can easily be made suitable for submerged arc welding.

Extensive investigation has been carried out on the subject of electric welding in an inert gas, and typical examples of sets for this class of welding are being shown. In this field the aim of the company is to increase the number of ways in which inert arc welding can be economically applied by ensuring the utmost economy in the use of gas, electricity and tungsten electrodes, and to provide equipment to extend the use of existing metallic arc sets to inert arc welding.

The a.c. inert arc welding equipment, which is illustrated in Fig. 8, has a rating of 250A and incorporates some novel ideas. When the set is idling the welding transformer and condensers are disconnected from the supply, and the gas and water supplies are cut off. Only a low voltage for operating the control relays is present at the electrode, thus reducing the risk of electric shock. To start welding the operator touches the workpiece with the electrode, which immediately permits the flow of gas and cooling water. The electrode is then lifted from the workpiece, whereupon the power voltage is automatically switched on, together with a high-frequency pilot voltage to start the arc. The high-frequency pilot voltage is only present when required to start the arc or to maintain it. On breaking the arc the welding voltage is immediately removed from the electrode, and the gas and water supplies cut off automatically after a delay sufficient to allow the electrode to cool in an inert atmosphere. If preferred, an automatic switch can be provided which enables the arc to be started without touching the work.

A surge injector unit (a development by the Electrical Research Association) is also on view. This unit is of great interest, as it enables the standard transformer arc welding set to be used for inert arc welding of light alloys. It allows the arc to be started without the electrode actually touching the work, and afterwards maintains the arc by injecting a pulse or surge of direct current immediately after the welding current zero (when the electrode is positive), thus overcoming the problem of current rectification. The equipment is suitable for work where transformer arc welding equipment is available, but where there are insufficient applications for inert gas welding to justify the installation of the inert arc equipment previously described.

A flow control unit, also shown, is designed to provide automatic control of the flow of gas and water when inert arc welding is carried out using direct current ; it can also be supplied for use in conjunction with the surge injector unit. Before starting to weld the operator presses a button, which starts the flow of gas and water. The control permits the flow of gas and water during welding, and for a preset time after the arc is broken to allow the electrode to cool in an inert atmosphere.

W. and T. Avery, Ltd.

One of the fatigue testing machines shown upon the stand of W. and T. Avery, Ltd., Birmingham, which has not previously been dealt with in these columns, is the " Pulsator " fatigue tester illustrated in Fig. 9. In this push-pull, dual mass, resonance testing machine the dynamic force is introduced by an oscillating system comprising a helical spring, oscillated by an out-of-balance rotor, which builds up the oscillation of the spring to the required alternating load. Operation of the machine is carried out on the rising portion of the resonance curve and not on the peak. This avoids exceptionally high sensitivity of load to small frequency changes and has the advantage that the load can be varied while running, by regulating the frequency. A second helical spring is employed to apply initial static loads to the test specimen. With this arrangement it is possible to apply an initial tensile or compressive static load up to 10 tons on specimens in the machine, and superimpose an alternating load of from plus or minus 1 ton to plus or minus 10 tons by means of the exciter unit.

Both static and dynamic loads are measured by a loop dynamometer fitted with a microscope. Through the microscope the amplitude of deflection of the dynamometer is measured by means of an illuminated slot diaphragm and graticule. An amplitude regulator is fitted to the machine and through an electronic relay this regulator is used to control the frequency and load on the specimen within small permissible limits. The maximum amplitude of oscillation is plus or minus 6mm and the frequency is about 2200 cycles per minute.

The machine consists of a heavy bed to which are attached two helical springs for static and dynamic loading respectively. The springs are built concentrically, both being fixed at one end to the loading face plate, which is supported on vertical struts having flexible joints which anchor the oscillating unit to the bed.

The inner spring for applying the static load is fitted with an adjusting screw at the opposite end to the face plate. This screw passes through a boss at the end of the machine bed and through it the load is applied by means of nuts and spanner. The outer spring for applying dynamic loads is freely supported at its end opposite to a face plate on vertical struts similar to the face plate supports, and is free to oscillate axially under the forces imposed by the exciter unit fitted to the end of the spring.

The totally enclosed exciter unit consists of an out-of-balance rotor mounted on ball

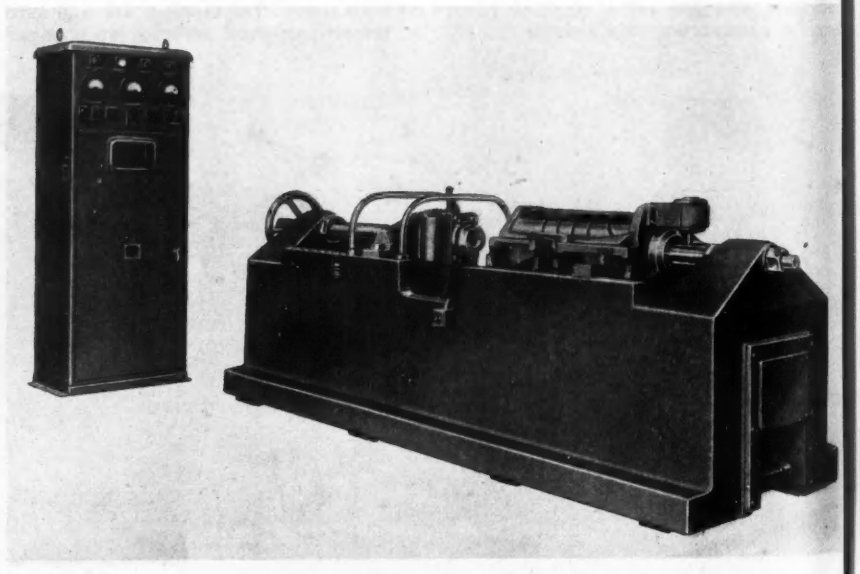

Fig. 9—Fatigue Testing Machine—Avery

and roller bearings and driven through a flexible shaft by a 1½ h.p. d.c. motor fitted in the machine bed. A revolution counter geared to the motor records the number of cycles imposed by the rotor.

The specimen to be tested is fitted into grip-holders, one of which is mounted on the loading face plate and the other on the dynamometer. There is ample space between gripping plates to accommodate full size components and, if required, special equipment for carrying out low or high-temperature and corrosion tests.

The loop dynamometer for measuring the load on the specimen is carried on a bridge which traverses along the sides of the bed and can be bolted in any position from 12in to 4ft between face plates. Adjustment of the bridge is by means of a hand wheel and screw.

From the remote control unit the dynamic load on the specimen can be varied by slight alteration of the speed of the out-of-balance rotor of the exciter unit, and when the desired dynamic load has been reached provision is made for it to be automatically maintained.

One of two other dynamic fatigue testing machines on this stand is designed to apply reversed bending stresses, with or without initial static load, and it can be used for testing thin plate or round specimens. With suitable specimen grips torsion tests, or combined torsion and bending tests, can be carried out on this machine. The other machine is for rotating cantilever tests and is designed for testing two specimens together.

Ruston and Hornsby, Ltd., and Davey Paxman and Co., Ltd.

The two associated companies, Ruston and Hornsby, Ltd., Lincoln, and Davey Paxman and Co., Ltd., Colchester, are showing on a combined stand a representative range of oil engines for marine, industrial and rail traction applications.

One of the engines representative of the Ruston-Paxman "Y.L." series and particularly suitable for rail traction purposes was shown in the last exhibition. It is a twelve cylinder unit developing 1125 b.h.p. at 750 r.p.m.; engines to this design are made in eight, twelve or sixteen cylinder models, with normal aspiration or pressure charging, developing from 511 to 1500 b.h.p.

A "12 YHX" engine on the stand having twelve cylinders with a bore of 7in and a stroke of 7½in is manufactured in light alloy, and develops 800 b.h.p. at 1250 r.p.m. It has a dry weight of only 7800 lb and is available for marine, industrial or rail traction work. This engine was originally built to Admiralty requirements and its design has now been generally released.

The engine (Fig. 10) has a heat-treated aluminium alloy cast crankcase which, through an extruded aluminium bearer, provides mounting supports for the whole unit. Separate cylinder blocks which carry wet liners are fastened by high-expansion austenitic steel studs. The aluminium alloy cylinder head castings embody two exhaust and two inlet valves, there being no cutaways in the liners. A copper ring located in the top flange of the cylinder liner forms the gas-tight joint and the heads are secured to the cylinder blocks by six steel studs. Efficient cooling of the valve seats and the injector is effected by passing the cooling water downward around the injector and then spraying it out over the bottom deck of the cylinder head.

Aluminium alloy pistons are fitted with three compression and two oil control rings and can be removed through doors in the crankcase. Steel stampings of "H" section form the connecting-rods, the forked rod being connected by means of four high-tensile steel bolts to the big end block, which is chromium plated on its outer diameter to ensure minimum wear for the blade rod bearing track. The underslung forged steel crankshaft, which has solid pins and journals, is carried in aluminium alloy bearing caps.

The camshaft, of chill-cast Monochrome iron, has two cams per cylinder, and is located centrally in the cylinder vee in a self-contained cambox. A heavy-duty duplex chain drives the camshaft from the engine crankshaft. The camshaft operates parallel motion valve gear through swinging hardened steel roller cam followers, tubular push rods, and pressure lubricated valve rockers made of aluminium alloy stampings. The fuel pumps are mounted immediately above the camshaft and driven from it.

A hydraulic servo flyweight governor

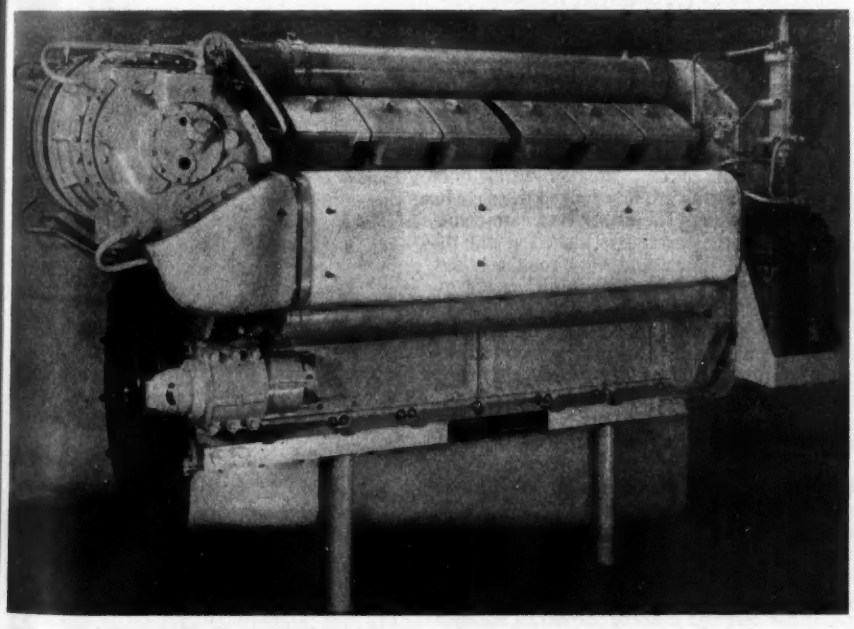

Fig. 10—800 b.h.p. Light Alloy Oil Engine—Davey Paxman

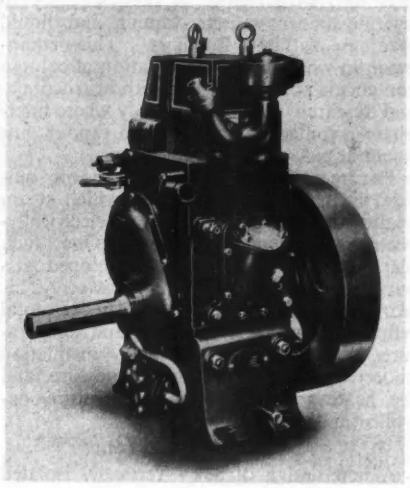

Fig. 11—"IVTH" Oil Engine—Ruston

is actuated by the engine oil pressure and acts as a safety device should the lubricating oil supply fail. Two exhaust-driven turbo pressure chargers are mounted on brackets attached to the crankcase at the drive end of the engine.

A small Ruston engine exhibited is the "IVTH" model illustrated in Fig. 11. This design of single-cylinder engine can be arranged to develop from 3¾ b.h.p. at 750 r.p.m. to 7½ b.h.p. at 1500 r.p.m. It has a deep section bedplate and housing cast in one piece and completely enclosing all the reciprocating and rotating parts. A water-jacketed cast iron cylinder head carries the overhead inlet and exhaust valve gear and the injector. A plunger release fuel pump is fitted and the injector has an edge filter. The crankshaft is extended to take a driving pulley and if the engine is required for driving a d.c. generator or alternator it can be fitted with two flywheels.

Scale models displayed on the stand show a Paxman rotary vacuum filter; an "Ultranomic" boiler, and a package set power unit for oil well drilling.

Quickfit and Quartz, Ltd.

The principal exhibit on the stand of Quickfit and Quartz, Ltd., is a large, all-glass vacuum still, using steam as the heating medium. This still, which is demonstrated in operation, illustrates some of the more important features of the firm's range of plant for the unit operation of distillation. It includes multiple heat exchangers using steam at 50 lb per square inch pressure to provide reboil heat, packed column sections and total condenser, reflux control and a vacuum offtake system.

Reboilers in the circulatory arrangement give good thermal circulation and a short contact time, whilst column sections in various sizes facilitate modifications to platage and provide accommodation for a wide range of reflux ratios, which may be varied during operation to give constant overhead product during batch working. The use of intermediate and final vacuum receivers enables the product to be withdrawn without shutting down and breaking the vacuum. This type of unit is designed to provide the high degree of flexibility required in development and pilot-scale work, and it can in addition be used as production-scale plant in manufacturing fields where purity and close control of product are essential.

A second exhibit on the stand demonstrates some of the characteristics of column

packings, with regard to their capacity to operate under various vapour and liquid loadings without flooding. This equipment, in which visual examination of column contents is possible, provides an instructional and research method for study where interphase contact—either liquid/vapour or liquid/liquid—is of interest.

For reaction and distillation work outside the temperature range in which steam heating is effective, a series of electrically-heated plant units is made. One such plant, fitted with the recently developed gas-purged heating mantle is shown. This plant provides for reaction under total reflux, with stirring, gas-bleed and temperature measurement, followed by distillation under atmospheric or reduced pressure, and the heating equipment is temperature-controlled and nitrogen-purged.

A. Reyrolle and Co., Ltd.

A new design of 33kV vertically isolated duplicate busbar switchgear is being shown (Fig. 12) by A. Reyrolle and Co., Ltd., Hebburn, Co. Durham. With this "L42T" switchgear only one construction of circuit breaker is required, whether it is for single busbars or for duplicate busbars, whether for feeder, generator or transformer circuits or for busbar-section or busbar-coupler panels. Provision is made for earthing the line or the busbars by a novel method requiring no ancillary apparatus, and the arrangement is such that the line or the busbars are earthed within their own zone of protection.

In a duplicate busbar panel one set of busbar orifices is situated on either side of the circuit orifices so that the circuit breaker can be plugged in to select the required busbar. At the same distance on the other side of the busbar orifices are earthing plates, and either busbar can be earthed by plugging in the circuit breaker at the appropriate position and closing it. A second set of circuit orifices is provided beyond the current transformers so that the circuit can be earthed within the zone of its protection. These orifices are also used for the voltage transformer when one is needed. In Fig. 13 the various positions of the circuit breaker in a duplicate busbar panel are shown diagrammatically.

The circuit breaker is easily moved from one position to another by means of a lifting and traversing carriage, which is captive in the panel and is operated from controls on the front of the panel. Lifting is done electro-hydraulically, lowering by gravity, and traversing by hand. The operation is so simple that it is possible to transfer a circuit from one busbar to the other in less than three minutes. To lower the circuit breaker, the motor-operated pump is switched on and the arms of the carriage rise and take the weight of the circuit breaker; the anchor bolts securing the circuit breaker to the frame standards are withdrawn, the lowering valve is opened, and the ram of the carriage descends with the circuit breaker, the oil in the ram passing into a storage tank. To move the circuit breaker to a new position the position selector handle on the front of the panel is set appropriately, and the carriage is moved backwards or forwards with the circuit breaker by means of a manually cranked screw mechanism. When the carriage reaches the selected position a locking bolt registers automatically, and the motor can then be switched on, to lift the circuit breaker to its fully home position, where it is anchored to the frame standards.

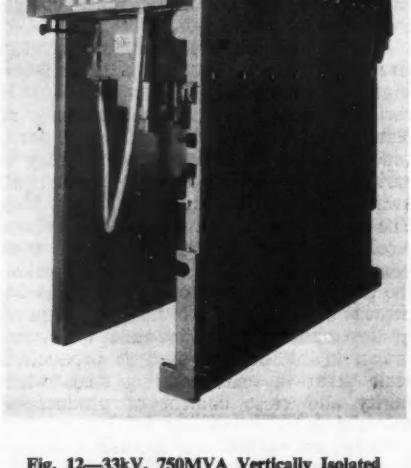

Fig. 12—33kV, 750MVA Vertically Isolated Circuit Breaker Panel—Reyrolle

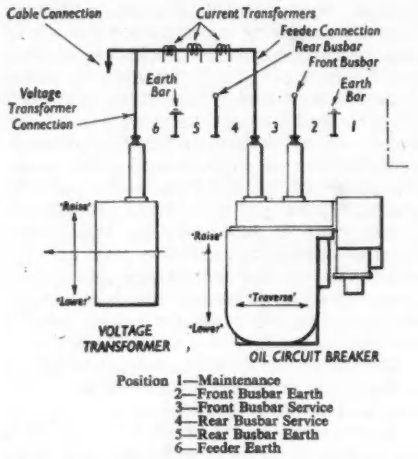

Fig. 13—Circuit Breaker Positions in Duplicate Busbar Panel—Reyrolle

The same carriage is used to lower the voltage transformer when it needs maintenance or when the circuit or the back busbar is to be earthed. For maintenance, the voltage transformer is transferred to a bogie in the passageway behind the switchgear; but when the circuit or the back busbar is to be earthed the voltage transformer may be left in its lowered position on the carriage.

The various operations involved in the transfer of the circuit breaker from one position to another are interlocked to prevent wrong operation. The lifting ram cannot be raised unless the carriage is locked at one of the correct positions, and the circuit breaker cannot be raised without the tank, except in the maintenance position (Fig. 14). The circuit breaker anchor bolts cannot be inserted unless the secondary connection plug box is in position; until they are inserted the circuit breaker cannot be closed, and while the circuit breaker remains closed they cannot be withdrawn.

There is an extra interlock at each of the earthing positions, which functions as follows: the carriage cannot be locked in the selected earthing position until a key has been obtained to unlock a gate that otherwise obstructs the carriage locking bolt. The key can then be removed, but it is required again when the carriage is to be moved to another position. A different key is provided for each earthing position, and it is therefore impossible to select any of the earthing positions inadvertently. Orifice shutters are opened and closed by the raising and lowering of the circuit breaker, and can be padlocked in either position. If the circuit breaker is raised against a closed shutter the oil in the ram is automatically by-passed to the storage tank and no damage is done.

The circuit breaker is fully phase separated and has two breaks per phase. Both the main and the arcing contacts are of butt form, and the circuit is broken in arc control devices that are easily removable by means of their breech block fixings. The isolating contacts are also butt contacts and allow considerable latitude of alignment in all directions. The circuit breaker has a solenoid-operated closing mechanism with a single dashpot for opening and closing, situated in front of the circuit breaker so as to be accessible for adjustment. A special attachment containing a closing spring is provided for use in an emergency if the solenoid is inoperative. This is capable of closing the circuit breaker at its full making capacity. When it is to be used, the spring is charged, the attachment is fixed on the circuit breaker mechanism, and the spring is tripped by hand to close the circuit breaker.

All maintenance of the circuit breaker can be done with it on the carriage in the maintenance position at the front of the panel. To permit transfer of circuit breakers between panels a light three-wheeled truck that does not need floor rails is provided.

For the fixed portion of the equipment single or duplicate busbar panels are available, with sheet steel double barrier frame standards accurately drilled to ensure correct positioning of the chambers, which are lifted between the standards during erection. All orifice insulators are of "bakelised" paper with capacitance grading and are identical for all chambers.

The busbars are of tape-insulated, circular, solid, copper rod, carried in compound-filled chambers. Self-aligning links with silver-plated contact faces allow for longitudinal expansion; they are used to join the busbar conductors of adjacent panels and are contained within compound-filled elliptical band joints. Two busbar ratings are available, namely, 1200A and 1600A, and the busbars may be phase separated or non-phase separ-

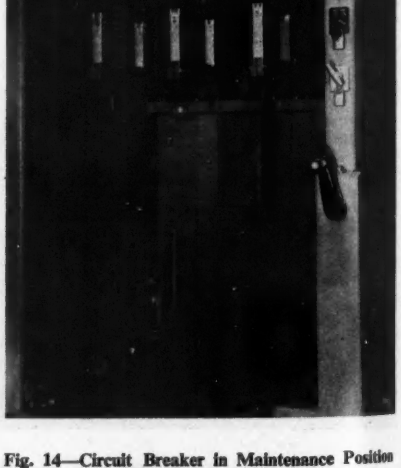

Fig. 14—Circuit Breaker in Maintenance Position with Tank Removed—Reyrolle

ated in the same size of chamber. Flat silver-plated contacts in the busbar orifices ensure good current transfer from the scissor isolating contacts of the circuit breaker, and provision is made for inserting a high-voltage or current-injection test plug into any of the orifices.

The bar type bushing mounted current transformers are in air behind sheet steel covers at the top of the fixed portion, and are easily accessible for testing. They can be removed on site by draining the oil from the top portion of the front vertical connecting chamber and removing a door on it. This makes it possible to remove the front connection to the bushing and also the top portion of the chamber itself. The current transformers can then be drawn forward off the bushing, which remains connected and supported at the back end. The current transformer chamber connections can be phase separated or contained in a common chamber. The voltage transformer is phase separated and oil filled, and has a high-voltage fuse in a separate compartment in each plug bushing.

Three single-core cables or one three-core cable can be connected by using suitable cable boxes in conjunction with a common adaptor chamber. For other combinations a larger adaptor chamber with identical fixings is supplied. The multi-core cable gland is housed inside one of the frame standards, where it is fully protected, and the multi-core cable terminals are accessible from the floor at the rear of the panel.

Armstrong Siddeley Motors, Ltd.

To show clearly the design and construction of the two sizes of air-cooled diesel engines it makes, Armstrong Siddeley Motors, Ltd., of Coventry, has sectioned models in operation on its stand as well as examples of production engines in use with welding, generating, pumping plant, &c. The smaller of the two engines is a single-cylinder unit with a range of power ratings from 5 to 8 b.h.p. at 900 to 1500 r.p.m., which can be selected according to the duty specified. It has a bore of 4½in and a 4½in stroke.

This single-cylinder engine—see Fig. 15—has a cast iron crankcase fitted with light alloy cover plates which give good accessibility to the big-end bearings. The cylinder and its head are a single iron casting, and a rocker standard mounted on the cylinder head carries the valve-operating rockers, which are easily accessible for maintenance purposes. A light alloy piston is fitted with three compression and two slotted oil-control scraper rings, and its crown incorporates a hemispherical combustion chamber. Mounted on the front end of the crankshaft is a spur gear which drives the camshaft and the oil pump. An extension of the camshaft protruding from the crankcase provides an alternative drive at half engine speed, and starting dogs for engagement with the engine starting handle are fitted at the extreme end of the camshaft.

The governor used for controlling the fuel pump consists of two radial grooves formed on the outer face of the camshaft gear wheel; into each of these grooves is fitted a large steel ball which makes contact with an adjacent conical disc. This disc is linked to the fuel pump rack rod. As engine speed increases the balls are thrown outwards and move the conical disc, which is free to slide along the shaft against the pressure imparted by a calibrated spring. Movement of the disc along the shaft with increasing and decreasing engine speeds is transmitted to the fuel pump rack by the link, thus automatically adjusting the quantity of fuel pumped in accordance with the load on the engine. The engine cylinder and head are cooled by a blast of air from vanes formed in the flywheel. All the main bearings are pressure lubricated by a geared oil pump housed in the crankcase, the cylinder walls and gudgeon

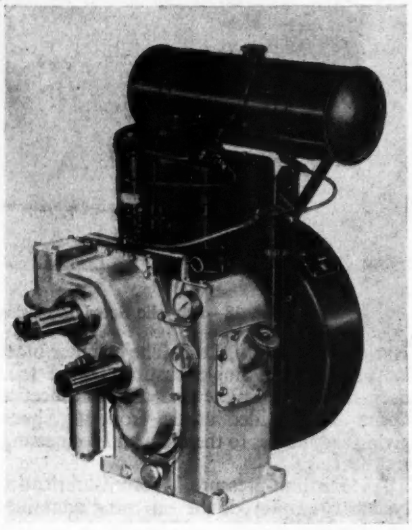

Fig. 15—Single-Cylinder, Air-Cooled Oil Engine—Armstrong Siddeley

pins being splash lubricated with oil from the big-end bearing.

The two-cylinder engine made by this firm has power ratings of 14, 16, 18 and 20 b.h.p. at 1000, 1200, 1350 and 1500 r.p.m. respectively, and many of its component units are similar to those used in the single-cylinder engine.

W. J. Fraser and Co., Ltd.

The work of W. J. Fraser and Co., Ltd., of Dagenham, can be broadly divided into two rather different aspects of chemical engineering—first, the construction of complete chemical engineering projects and, secondly, the design and manufacture of specialised items of plant. By means of photographs, diagrams and models, a number of special plant items are illustrated on the firm's stand, and typical examples of large-scale contracting work in various parts of the world are shown by films.

The working models include one showing a section of a distillation column fitted with the "Turbogrid" distillation tray, which

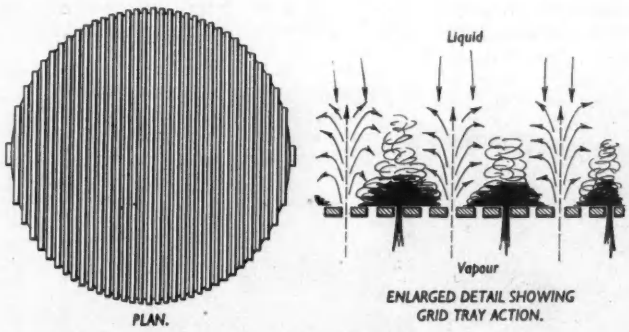

Fig. 16—"Turbogrid" Tray Arrangement and Operation—Fraser

the firm makes under licence from the Shell Petroleum Company, Ltd. It is claimed that in certain processes, particularly those in which liquid load is high—as in de-ethanizers, de-propanizers, stabilisers and absorbers—or where column height is limited, this new vapour-liquid contacting tray is superior to the bubble-cap tray. The new trays, which have proved successful both in chemical and refinery installations, can be adapted for existing plant. They are easily serviced and are of simple, robust design. A diagram we reproduce in Fig. 16 shows the arrangement and operation of one of the grid trays.

The tray consists essentially of a flat grating which extends uniformly over the entire column cross section. The rectangular struts of the tray are of dimensions and in number appropriate to the particular application, and they are so designed that the flow of liquid is turbulent with good vapour-liquid contact. The makers say that the separation is equivalent to that of a bubble-cap tray and the simple shape and greatly reduced flow resistance of the new tray give it a much greater capacity with less pressure drop.

Babcock and Wilcox, Ltd.

As the majority of the plant it manufactures is far too large and complicated to exhibit, Babcock and Wilcox, Ltd., has made good use of photographs and models on its stands to give some impression of the wide range of equipment it supplies for industrial and marine engineering. The land boiler exhibits include a model of one of the 830,000 lb per hour radiant units at present under construction for Castle Donington power station, and models of high head, bi-drum and integral-furnace units, as well as photographic enlargements of typical installations. Marine boilers are represented by models of single-pass header, integral furnace and divided-furnace controlled superheat units, together with scale models of typical vessels in which these types of boiler are installed. Many of these boiler designs have been already described in the columns of THE ENGINEER in articles dealing with actual land installations and ships and are now generally well-known.

It is of interest to note that the marine "air-puff" soot-blower is now being manufactured in this country by Dewrance, Ltd., a subsidiary company of Babcock and Wilcox, Ltd. These blowers use compressed air in puffs to clean boilers, superheaters, economisers and air heaters. They are pneumatically operated and automatically controlled once the air supply has been turned on. The supply of air at about 130 lb per square inch is connected to a master control unit, and to the soot-blower on the boiler. Through this controller a pawl is operated by a pneumatic piston on the blower and serves to turn the cleaning jet tube through an angle of 20 deg. as the cleaning air blast is released. In a succession of puffs of air the blower is rotated until its arc is completed and the control unit then directs the air supply to the second blower, and then others in turn.

The welding research section of the Babcock and Wilcox organisation has arranged some interesting demonstrations of its work, including two comparatively recent developments in the use of ultrasonic testing methods. One of two test rigs used for these demonstrations is intended to show the application of ultrasonic testing where only one side of a specimen is available, and it is used in connection with butt-welded pipe joints. In this rig the transmitter and receiver units are mounted on an annular

track surrounding the pipe so that they can be traversed round its circumference. Various forms of experimental applicator probes are shown, together with the commercially available cathode-ray oscillograph with which they are designed to be used. The other test rig shown is for experimenting with various methods of examining specimens where access to both sides can be obtained. In it an ultrasonic beam, generated at about 2-3 Mc/s by a crystal unit immersed in a tank of water, is focused on the specimen by means of a " Perspex " lens. At the rear of the specimen, and separated from the main tank by a flexible partition, is a cell containing a liquid suspension of metal particles which, by differential orientation under the action of the ultrasonic beam, as interrupted by the specimen, give an image of the specimen in which holes drilled to represent flaws can be clearly seen.

It is believed that a unit known as the " Levelscope," being demonstrated on this stand by Bailey Meters and Controls, Ltd., is the first application of closed-circuit television for remote water gauge indication commercially available in Britain, although a number of installations exist in the United States. The " Levelscope " consists of a simple camera unit with power pack incorporated, and a receiver unit mounted in some convenient position. In certain circumstances a " rear cell " unit, clamped on the water gauge, may be necessary with some types of gauge. The transmitter and receiver are coupled with an ordinary coaxial cable, and the equipment uses components which are readily available commercially. No special lighting is required, the camera carrying its own built-in ultra-violent lamp, so that it can operate, if necessary, in total darkness.

W. H. Allen, Sons and Co., Ltd.

The exhibits of W. H. Allen, Sons and Co., Ltd., Bedford, demonstrate some of the plant it designs and constructs, including power generating plant, pumping machinery and electrical equipment for all branches of industry.

The largest exhibit on the stand is a 500kW diesel generating set, comprising a six-cylinder, 333 r.p.m. engine, directly coupled to a 588kVA, 0·85 p.f. alternator. This class of unit (see Fig. 17) is constructed in three to eight-cylinder sizes for power outputs from 218kW to 750kW.

The two-stroke, airless-injection, compression-ignition " T47 " engine of this unit operates on the uniflow scavenge principle, and is manufactured under licence from Harland and Wolff, Ltd. The cylinder block is formed in a single casting bolted to a deep-section bed-plate and ample inspection doors are provided at the front and back, giving easy access to the main and connecting-rod bearings.

A medium-pressure, forced-lubrication system is employed, the oil being contained in the engine bed-plate. The gear lubricating pump is directly driven from the engine crankshaft, and supplies the piston cooling and engine pressure system through an oil cooler, via a large double-compartment filter. Oil passes through the main bearings to the big-end bearings and then up the connecting-rods to the small-end bearings, while an independent supply feeds the camshaft and governor.

Two exhaust valves of heat-resisting steel operated from a single fulcrum are mounted vertically in each cylinder head. The fuel injection valve is centrally disposed in the cylinder head and a spring-loaded pressure-relief valve is fitted. A centrifugal spring-loaded governor regulates automatically the fuel supply at all loads and its adjusting gear enables the speed to be varied by hand whilst running. The engine exhibited is fitted with motorised speeder gear to facilitate remote control from the alternator switchboard. The governor is driven from the crankshaft by the same roller chain that is employed to drive the camshaft and a positive rotary displacement blower at the back of the engine. A separate fuel pump is employed for each cylinder, the pump being mounted high in the engine frame and directly actuated from the camshaft, an arrangement which enables individual adjustment of each pump to be carried out in order to obtain equal distribution of load over all the cylinders.

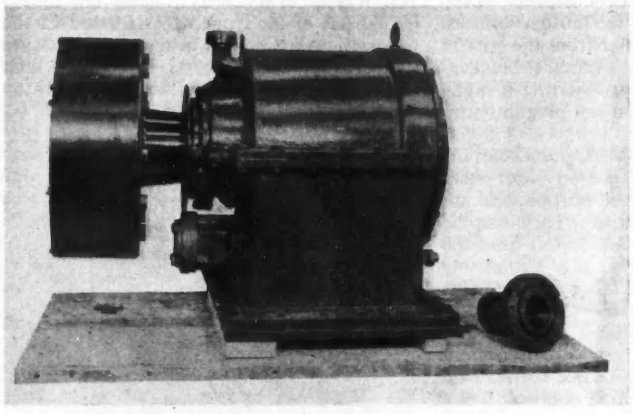

Fig. 18—Epicyclic Speed Increasing Gear—Allen

The alternator, which is designed for parallel operation, is of open, rotating-field, salient-pole construction, running at the engine speed of 333 r.p.m., and having a full-load rating of 500 kW, 588 kVA, 0·85 p.f., three-phase, 50 c/s, 415V, with an overload capacity of 10 per cent for one hour. Its stator casing is of fabricated construction, and the segmental stator core is secured to the frame by dovetail keys. Class " A " insulation is employed for the stator windings, which are retained in open slots by bonded fabric wedges.

The shaft carries a fabricated steel hub to which are attached the laminated rotor poles. The rotor coils are layer wound on sheet steel spools using insulated rectangular copper. Damper windings are fitted in the rotor pole faces to assist in satisfactory parallel operation. Rotor-mounted fans draw ventilating air from both ends of the machine, expelling it through the top of the stator casing.

Flexibly coupled to the alternator shaft is a shunt-wound exciter. Voltage regulation is effected by an automatic voltage carbon-pile regulator, together with a hand-operated regulator for standby use.

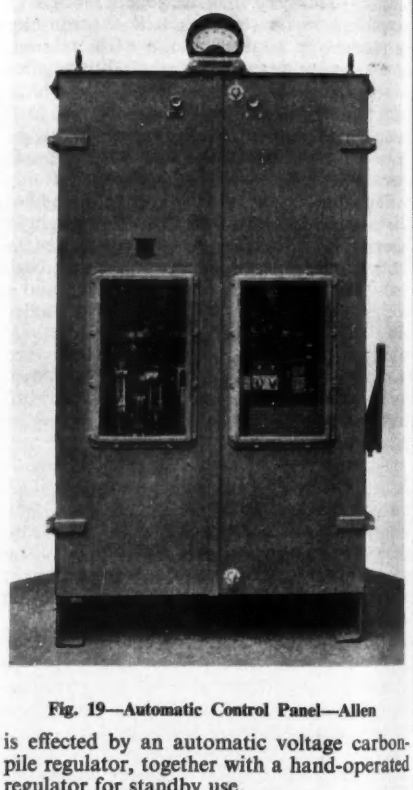

Fig. 19—Automatic Control Panel—Allen

Also displayed on the stand are various units of " Allen-Stoeckicht " double-helical epicyclic gearing, indicating some of the duties and applications for which this gearing is employed. These gear units, one of which is illustrated in Fig. 18, are being supplied for turbine and other forms of drive, for the transmission of powers up to

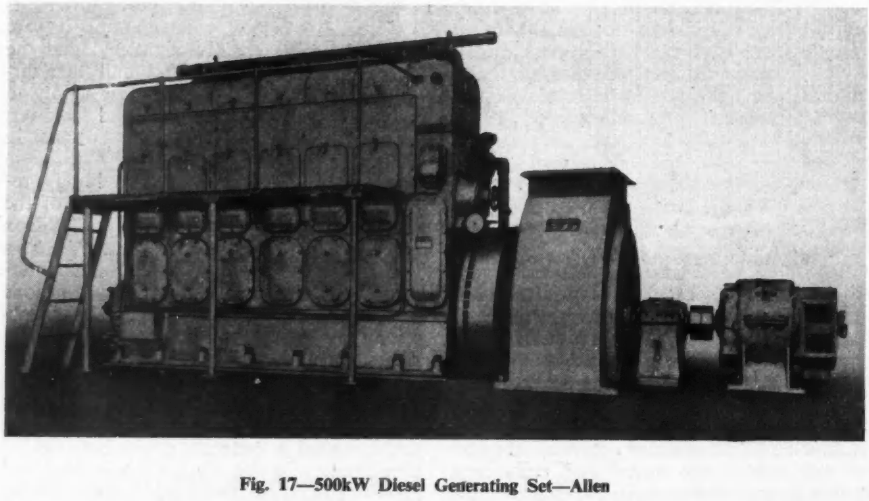

Fig. 17—500kW Diesel Generating Set—Allen

5500 h.p., for both industrial and marine service. They are particularly adaptable for gas turbine and steam turbine drives and test rigs.

A complete double-reduction, double-helical, epicyclic gear for a 650 h.p., 16,500/600 r.p.m. steam turbo-generator exhibited has the top-half cover removed to show the internal arrangement. The unit consists of two epicyclic reduction trains in series, the first train being a star gear and the second a planetary gear. The gearbox low-speed shaft bearing supports half the weight of the generator armature and the gearcase supports half the weight of the turbine at the high-speed end.

Another epicyclic gear which can be seen on the stand is a unit with compound planet wheels for a 72 h.p., 16,000/775 r.p.m. inclined-spindle steam-turbine-driven main circulating pump. The internal parts of this gear are mounted on a pedestal designed to permit the parts to be rotated continuously at a low speed in order to show the epicyclic action.

One of two a.c. motors shown on the stand is a vertical-spindle, drip-proof, two-bearing, synchronous, induction machine for driving an Allen dock pump, and designed for a full-load rating of 125 h.p., 1·0 p.f., three-phase, 50 c/s, 415V, running at a speed of 600 r.p.m. It has a motor frame of fabricated construction with a flange at the driving end for direct mounting on the pump. The laminated stator and rotor cores are keyed to the stator frame and shaft respectively and are provided with semi-closed slots carrying " Class A " insulated bar windings. The rotor slots are skewed to reduce noise and provide smooth acceleration. The slip rings and brush gear are located above the upper bearing in a housing which carries the rotor terminal box and also supports the exciter.

Allen control gear is represented by one of three similar equipments which are to be installed in a new passenger liner, each to control a 151 h.p., 220V, d.c. motor driving a double-inlet forced draught fan. The control panel (Fig. 19) of the equipment is of the automatic contactor design, arranged for remote control from an enclosed-ventilated drip-proof unit, which is also part of the equipment. The equipment is designed to cover a speed range of approximately 5 to 1 by a combination of armature resistance and shunt-field control. On pressing either the local or remote start button, the motor can be started and accelerated to any speed set on the remote controller. The motor may also be stopped from either position.

Another important mechanical component shown is a rotor for a 750kW pass-out turbo-generator, one of four sets under construction for a large new British passenger liner. Each of the turbines is designed to run at a speed of 8000 r.p.m., and to operate with steam at a stop-valve pressure of 525 lb per square inch gauge and a temperature of 790 deg. Fah., the pass-out steam quantity being 20,000 lb per hour at a pressure of 60 lb per square inch gauge, for use in low-pressure auxiliary services.

Wm. Gardner and Sons (Gloucester), Ltd.

Mixing machines for many classes of materials and in several sizes exhibited by Wm. Gardner and Sons (Gloucester), Ltd., Bristol Road, Gloucester, include the improved " Rapid " sifter mixer which has been made by the firm for a number of years. The machine has been redesigned to give increased facilities for cleaning, by making the internal agitator, as well as the brush and sieve, completely removable without disturbing any of the drives. A laboratory size mixer of generally similar constructions to this machine embodies the same principles of access for easy cleaning.

For the mixing of dry powders and granular materials there is a double cone blending machine. This machine has been specially developed for handling materials which are not easily mixed by the standard trough mixer with internal agitators. It has a double conical drum, and the mixing is achieved by the rotation of this drum on an axis at right angles to the conical portions. Owing to the fact that there are no internal agitators in the machine it is very easy to clean, and in the smaller sizes the drum can be made in halves so that one half can be removed completely when washing down.

An improved design of paste mixer comprises a self-contained unit with inbuilt motor drives which is arranged for tipping for emptying. The machine is fitted with a safety cover interlocked with the motors, which prevents access to the agitators during mixing but allows the cover to be opened and the agitators to run when the machine is tipped for discharging.

A model is shown of a complete mixing installation including conveyors, elevators and storage bins, and with automatic weighing and feeding to the mixer.

Fusarc, Ltd.

A manually-operated continuous welding machine is one of the welding developments which is being demonstrated by Fusarc, Ltd., Gateshead on Tyne.

This equipment is designed to use Fusarc continuous electrode, with which high welding speeds are claimed. For example, the company states that a $\frac{5}{16}$in horizontal-vertical fillet can be deposited at 17in per minute and a $\frac{1}{2}$in two-pass close square butt at a rate of 20in per minute on either side.

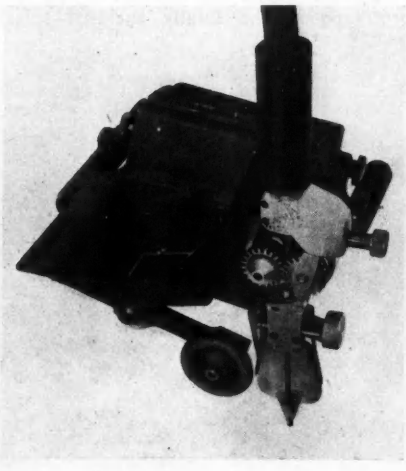

Fig. 20—Manual Continuous Welding Head—Fusarc

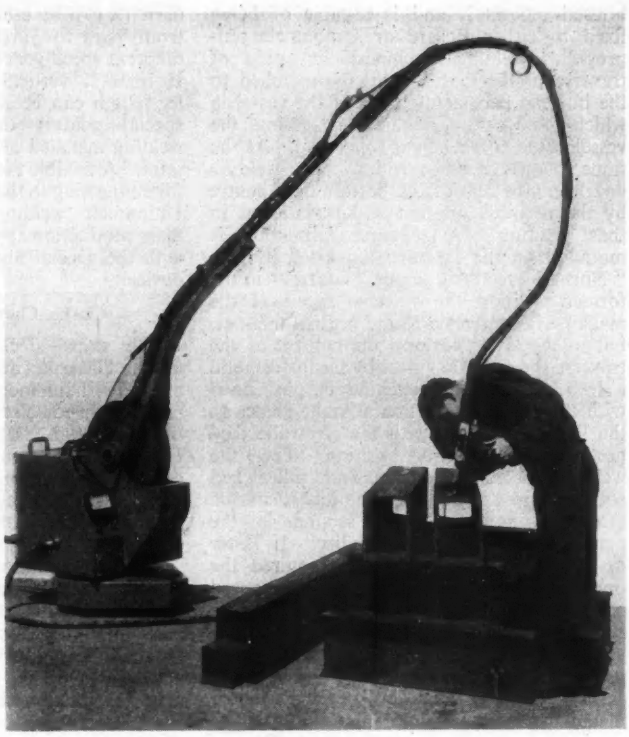

Fig. 21—Manual Continuous Welder—Fusarc

The manual continuous welding head (Fig. 20) is used in conjunction with a specially designed control cubicle, as shown in Fig. 21. The base is mounted on castors and carries the cubicle, which itself can rotate through 360 deg., thus enabling the whole control cubicle to be easily moved to suit welding shop requirements. The control cubicle is fitted with a counterbalanced arm, which supports the hollow electrode carrying cable to the welding head, and it relieves the welder of the weight of the cable, gives him greater freedom of movement, and keeps the floor area free from all control cables. The equipment is capable of operating over a radius of 3ft to 15ft through 360 deg., and, when used in conjunction with manipulating equipment or welding jigs, high arcing times can be achieved.

The welding head contains a drive unit and fulfils two main functions: feeding the electrode and traversing the welding head (through the pivoted power-driven castor wheel). Both functions are independently controlled by thumb controls conveniently situated to the right and left handles of the machine. The welding conditions for a particular job can be preset on the scales on the upper face of the welding head, and the operator has only to make slight adjustments to the rate of feed as welding proceeds to maintain an even arc length.

The arc is viewed through a built-in arc shield and the welder is not inconvenienced by a helmet. Fatigue is reduced because the welding head is supported on its driving wheel, and the operator has only to maintain the proper balance of the machine about the driving wheel. A fume disperser driven from the head motor helps to blow welding fumes away from the operator. The nozzle assembly and feed gear incorporate established Fusarc details, including spring-loaded copper conducting jaws and dual drive to give a positive feed.

Another demonstration on this stand shows a Fusarc self-propelled automatic welding machine specially adapted for internal welding of a vessel such as a boiler drum. By a pendulum controller (which is

housed separately and is capable of being fixed to either Fusarc or Unionmelt self-propelled welding machines) the speed of traverse of the machine can be matched to the internal peripheral speed of the vessel in which the welding machine is running, the vessel being rotated by a roller bed. At the same time the actual position of the welding nozzle can be offset from bottom dead centre by the required amount and maintained in that position. A separate switchbox is mounted on the machine to switch it from "Normal" to "Automatic" control—in the former position the traverse speed of the machine is controlled in the normal manner, but in the latter position the control of the traverse speed is taken over by the instrument.

In operation the machine is positioned with the turret centre line at right angles to the line of traverse, with the electrode feed nozzle in the required position. Then the welding machine traverse and roller bed rotation are started and welding is started after allowing about twenty seconds for the pendulum controller to stabilise. If faster or slower welding speeds are required the operator need only alter the roller bed speed control, which is brought to the switchbox on the welding machine, and the pendulum then automatically adjusts the speed of the self-propelled carriage to match the new speed of rotation of the vessel. This specially adapted machine enables all internal welding to be carried out when the normal method of boom-mounting an automatic welding head is impracticable when the length of the vessel is too great, or when the design of the vessel is such that the boom cannot be brought into position for welding.

The same company is also showing the new British-made "Unionmelt D.S." self-propelled welding machine and the "Unionmelt D.S." welding head, demonstrated in its stationary form on a specially designed Fusarc reclamation machine. The self-propelled welding machine has a broad field of application. With a current capacity of up to 1200A, it will weld from 16 gauge to ¾in thick plate in a single pass and any thickness by multi-pass welding. Automatic arc control is provided by a simple series control. The electrode wire feed drive is obtained from a series motor through a double worm reduction gearbox. This drive unit has a single-point swivel mounting so that the angle of the welding nozzle can be swung from the vertical to horizontal position. Horizontal and vertical adjustment slides are positioned close to the welding nozzle in the most convenient position for the operator. These adjustments are used for rapid positioning of the welding nozzle when setting up, and for keeping it aligned with the joint when welding. Various welding currents can be used with any wire diameter from $^{3}/_{32}$in to ¼in diameter with the three different speed gear reduction units available. Horizontal vertical fillet welds up to ⅜in leg length can be made in one pass using a special guiding device which keeps the welding installed accurately aligned with the joint. A flexible attachment is also available for connecting to the welding head for manual Unionmelt welding. Rapid starting for mass production applications can be obtained with the special high-frequency and starting device.

Clarke, Chapman and Co., Ltd.

The ships' deck equipment shown by Clarke, Chapman and Co., Ltd., of Gateshead, 8, Co. Durham, includes a working model of a prototype 3-ton electro-hydraulic cargo winch of new design. This winch, to be seen in Fig. 22, is a compact, self-contained unit complete with a prime mover which can be either a squirrel-cage motor for a.c. supply, a shunt-wound motor for d.c. supply, or an oil engine.

In this unit the motor or engine drives a hydraulic pump which is connected through a control chest to a hydraulic motor. This hydraulic motor in turn drives the winch barrel through two-speed spur gearing totally enclosed in an oil bath. The prime mover and the pump run at a constant speed, while the winch is operating, a speed control being obtained by varying the amount of oil delivered to the hydraulic motor through the control chest. In slow-speed gear a standard 3-ton winch of this design raises a load of 3 tons at a creep speed of 0ft to 14ft per minute, or at top speed of 100ft per minute. In quick-speed gear 1½ tons can be lifted at a creep speed of 0ft to 28ft per minute, or at 200ft per minute.

The hydraulic pump and hydraulic motor fitted to the winch are radial multi-cylinder units. The pump has nine rams, six being of large diameter and three of small diameter. Six rams of equal diameter are fitted in the motor. In the control chest, piston valves are operated by two levers by means of which loads can be hoisted at creep or full speed, suspended, and lowered at any desired speed. The rate of load lowering can be controlled hydraulically or by means of a foot brake which is fitted. Both the hydraulic motor and pump are enclosed and submersed in oil inside the oil reservoir tank.

As all parts of the hydraulic equipment and gear transmission run in oil the winch is quiet in operation and wear is reduced to a minimum. Overloading is controlled to within safe limits by an unloading valve fitted in the control chest.

Another model on this stand shows a prototype of the totally enclosed splash lubricated steam anchor windlass illustrated in Fig. 23. This design is intended to reduce the maintenance necessary on this class of winch, which is often situated in a very vulnerable and exposed position.

In this winch the engine and gearing are housed in a steel casing containing oil which gives protection against the weather, all the bearings and working parts being self-lubricating. The outboard frame bearings are, of necessity, external to the casing, but they are provided with force feed grease lubricators, requiring only an occasional turn.

Other models shown by the firm give an impression of the wide field of marine and industrial equipment it makes, including cranes, cargo winches, pithead gear, lighting units, boiler plants, &c.

A very fine working model of an electrically driven double-drum winder for a pithead gear represents a 350 h.p., spur geared, double-drum a.c. winder, arranged for a winding speed of 1180ft per minute. In this set, drums 10ft diameter by 4ft wide have cast iron cheeks and grooved mild steel treads, one drum being keyed to the drum shaft and the other being loose on the shaft. The loose drum is fitted with gun-metal bushes and is driven through a multi-toothed clutch so that fine rope adjustment can be obtained. It enables the drum to be fixed in any desired position and permits simultaneous decking when winding from different seams.

The clutch is operated by an oil motor mounted on the winder bed frame and is controlled from the operator's desk by a hand lever. This clutch is also mechanically interlocked with the drum brakes so that the clutch cannot be withdrawn until the drum brakes are fully applied. The motor drives through a flexible coupling and double reduction spur gearing, the gears being made in halves. The parallel motion centre suspended drum brakes are each operated by a quick-acting hydraulic brake engine supplied with oil at pressure of 110 lb per square inch from deadweight oil accumulator. The hydraulic pumps and accumulators, together with the electric control gear, can be seen housed conveniently under the winder house floor in the model.

Rhodes, Brydon and Youatt, Ltd.

A recent addition to the range of "Mopumps" made by Rhodes, Brydon and Youatt, Ltd., of Stockport, is the firm's "C.P." model which has been specially designed for use on chemical process plants. These pumps are of horizontal, single stage, centrifugal design and are made with 2in, 3in, 4in, or 6in inlet bores. The three models at present available are suitable for 35ft, 55ft, and 90ft head at 1450 r.p.m., or 150-200ft head at 2900 r.p.m. They are all built to

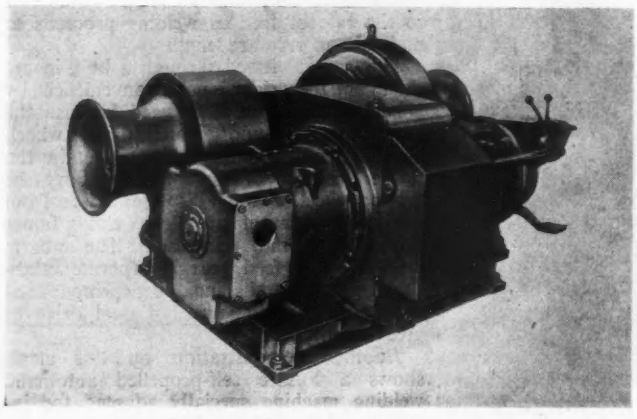

Fig. 22—Electro-Hydraulic Cargo Winch—Clarke Chapman

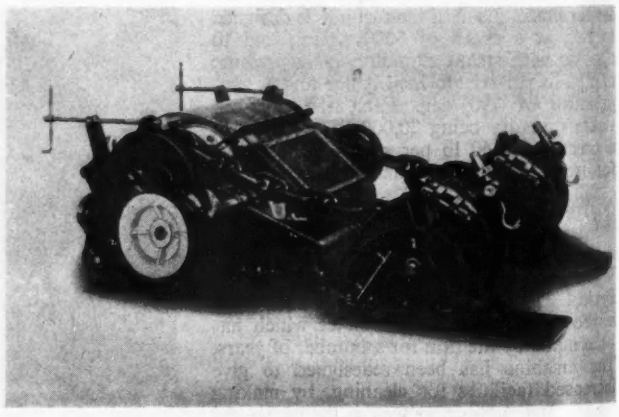

Fig. 23—Steam Anchor Windlass—Clarke Chapman

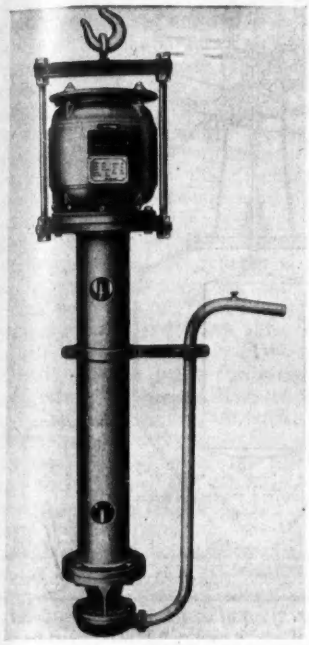

Fig. 24—Molten Metal Tank Pump—Rhodes, Brydon and Youatt

withstand a maximum static pressure of 100 lb per square inch and are suitable for operating temperatures of up to 300 deg. Fah.

A typical "C.P." pump is illustrated in Fig. 25. The volute cast iron casing incorporates both the suction and delivery branches and it can be assembled on the pump to provide "front" or "back" entry into the impeller. The arrangement is advantageous in relieving seal pressures. When pulling against a "lift" or vacuum the casing is fitted to permit entry into the impeller from the stuffing box side. When operating with high static inlet pressure the entry is from the opposite side, and radial pressure reducing vanes are provided in the impeller to reduce stuffing box pressure. A mild steel wearing ring is fitted in the casing and in cases where the pump is required to handle abrasive liquids this ring is replaced by a wearing plate.

The cast iron double-shrouded, single-entry impeller can be set on the stainless steel shaft according to the position of the inlet into the pump casing. A stainless steel shaft sleeve is fitted over the shaft, with a joint at the impeller, to reduce possibility of leakage creeping into the bearing housing via the shaft. A packed stuffing box and gland is fitted to the pumps as a standard, but the casing is designed to permit the fitting of a mechanical seal if required. A double sealing bush at the bottom of the stuffing box has tappings for grease and liquid seals. A distance piece cast integrally with the stuffing box forms a drop receptacle for any leakage which may take place.

In the bearing assembly, ball races are arranged in a cast iron housing to permit a certain amount of axial float, and oil seals are provided in both end covers of the pump. Axial thrust is taken by the coupling and duplex ball race. A spacer coupling is fitted so that the pump components and bearings can be removed for inspection or maintenance purposes without need for disturbing the pipe work or base assembly.

According to the purposes for which the pumps are required, the contact parts can be supplied in various metals or lined with protective materials and component parts fitted to suit special duties.

The firm is also showing one of its ¾in vertical pumps designed for transferring molten liquids at high temperatures. This pump (see Fig. 24) is arranged to be slung above a tank and lowered as the liquid level falls, so that it extracts only the top portion of the liquid, leaving scale, slurry, &c., at the tank bottom. It has a capacity of 10 gallons a minute at 3ft to 4ft head and is driven by a 1½ h.p. drip-proof squirrel-cage motor.

Major, Robinson and Co., Ltd.

To handle the very heavy gauge tubes used in industry the heavy-duty machine shown in Fig. 26 has been introduced by Major, Robinson and Co., Ltd., Warwick Road South, Manchester, 16. It is designed to bend hot finished seamless steel pipes up to 4½in outside diameter and 0·531in thick.

The machine is of heavy welded channel construction and has a 2⅝in diameter, 3 per cent nickel-chrome steel screw rotating in a large phosphor-bronze bush. This screw is driven by an electric motor through vee ropes and worm gearing mounted on ball and thrust bearings. The standard machine is fitted with a single low-speed, 3 h.p. motor and a reversing switch is fitted for load-releasing purposes. Two motors are fitted, however, to the machine illustrated, one being of high and the other of low-speed design, and each is coupled by vee belts to the main driving worm. These motors are interconnected to

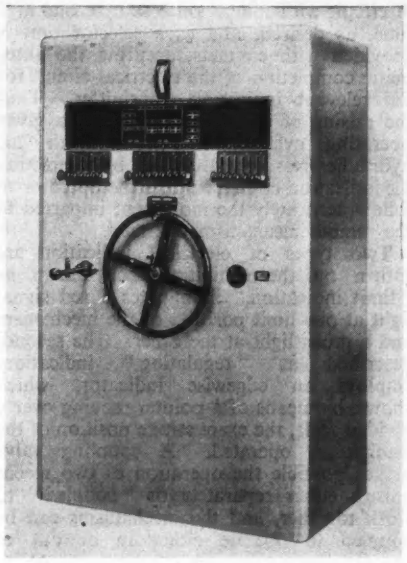

Fig. 27—Hydraulic Contro Cabinet—Automotive Products

push button switchgear mounted above the headstock of the machine, and one is used for slow speed when bending pipes, whilst the other gives a high-speed return motion to the leading screw for releasing.

The machine can be provided with formers ranging from ½in to 4in normal bore tubing, and, if required, multi-formers can be provided to enable more than one length of small diameter tubes to be bent in a single operation.

Automotive Products Company, Ltd.

Centralised hydraulic control systems are now widely used in many branches of industry and typical of this class of equipment made by the Automotive Products Company, Ltd., of Leamington Spa, is a small Lockheed centralised control cabinet shown as a working exhibit on the company's stand. This unit (see Fig. 27) incorporates a motor-driven hydraulic pump feeding the system through a panel-mounted metering and reversing valve which controls and directs the fluid flow. Manual hydraulic control is provided by a handy wheel-operated panel-mounted, four-cylinder or duo-directional pump. Auto change-over valves make either power or manual control immediately available.

Through selector valves various mechanisms operated through the set can be put

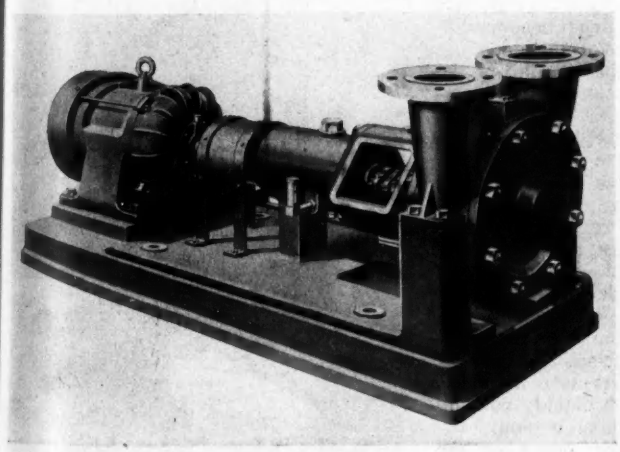

Fig. 25—Chemical Pump—Rhodes, Brydon and Youatt

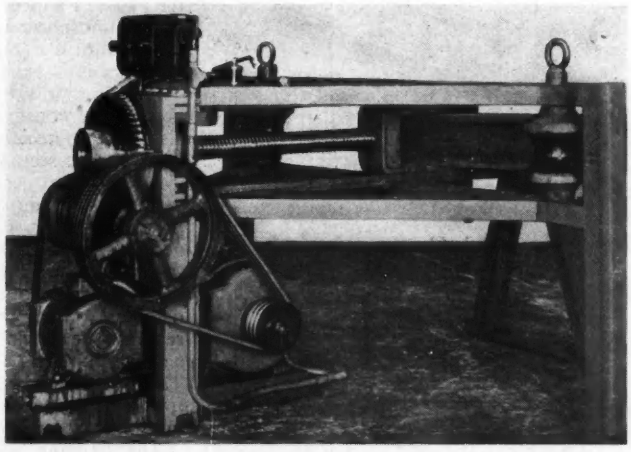

Fig. 26—Heavy-Duty Tube-Bending Machine—Major, Robinson

in circuit with the pressure source, one at a time, as desired, and each selector unit is provided with contacts, ensuring the automatic completion of the electrical circuit for the relevant indication transmitter. Thus the raising of a selector lever puts a given operating cylinder in circuit with the hydraulic pressure source, and, by completing the indication circuit, enables the operator to follow accurately the movement imparted to the remote mechanism operated.

Two types of electrical indication are shown on the exhibit. One, known as "limit indication," illuminates a red signal light at one limit position of the mechanism and a green light at the other. The second, described as "regulating" indication, employs an edgewise indicator, which shows, by means of a pointer moving over a divided scale, the exact stroke position of the mechanism operated. A coupling valve makes possible the operation of two mechanisms either separately or "coupled" to work together, and the mechanisms can be coupled to operate either in or out of synchronism.

Also exhibited on this stand are examples of "Purolator" metal element filters and "Micronic" filters with plastic impregnated paper elements, clutches, and flexible pipes and couplings.

Doulton and Co., Ltd.

Some recently developed units are demonstrated amongst the standard range of acid-proof chemical laboratory porcelain, chemical stoneware and porous ceramics on the stand of Doulton and Co., Ltd., Lambeth, London, S.E.1. One of these demonstration units shows a pipe-line filter assembly which embodies porous ceramic filter elements, "fixed flange" coupled chemical stoneware piping and a diaphragm pump.

With this recently introduced fixed flange method of coupling pipes there is no change of section in the stoneware which might lead to weakness at or near the joint. For this class of joint the pipes have their ends ground for squareness and to precise length, and the outer circumference is grooved. On assembly, as can be seen in Fig. 28, a malleable iron coupling piece is placed on each side of the joint, and a joint washer is placed between the pipe ends as they are aligned. Each coupling piece consists of a flange with an annular projection, in the bore of which are saw-tooth shaped grooves. The coupling pieces fit freely over the pipe ends, and before they are drawn together by means of their bolts a metallic jointing compound is placed between the circumference of the pipe and the machined bore. As the coupling pieces are drawn towards each other this metallic compound is forced into the grooves of the pipes and the saw-tooth grooves of the units themselves to give a tight grip and pull the pipes up on the intermediate washer. The material used for the joint washer can be selected according to the type of liquid flowing through the pipe and the conditions of service.

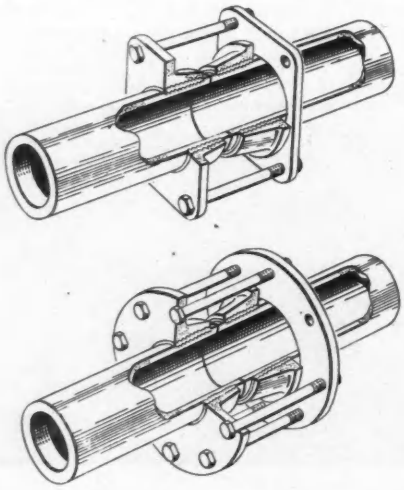

Fig. 28—"Fixed Flange" Pipe Coupling — Doulton

The porous ceramic materials used for the filter elements in this demonstration unit are, like the stoneware, chemically inert, rigid and have good stability at high temperatures. These filters can not only be used with water and other non-corrosive liquids but also with highly corrosive liquids and gases, both at normal and high temperatures.

For a demonstration of air-lift agitation a single porous ceramic element is used to produce agitation of a liquid with increased mixing efficiency by means of an air-lift—using approximately 12 cubic feet of free air per minute at low pressure. The arrangement shown is extremely simple and can readily be incorporated in existing plant. The same principle can be applied to transfer liquid from one vessel to another. An air supply line of a chemical stoneware guards against corrosive conditions and prevents contamination of the liquor.

Gresham and Craven, Ltd.

An improved design of its compressed air operated "Ejectopump" is shown by Gresham and Craven, Ltd., Ordsall Lane, Salford, 5, Manchester. This pump, with a suction lift of up to 10ft and delivery heads of up to 50ft, is shown, by way of example of the class of duty for which it is adaptable, pumping green peas suspended in water through 3in glass pipes.

In the improved pump the use of "Saunders" diaphragm valves has enabled the fitting of much smaller and lighter double-acting operating cylinders. By closing the space above the valve diaphragms to the atmosphere and putting it in communication with the top side of the operating cylinders it is expected that the life of the diaphragms will be increased. The compressed air consumption of the pump has also been appreciably reduced.

As can be seen from the drawing in Fig. 29, the pump consists of a cylindrical casing containing a float; a header incorporating an air ejector together with the necessary pneumatic valves; and a manifold to which are attached piston-operated diaphragm suction and delivery valves. It operates on a regular cycle comprising separate suction and discharge strokes giving a delivery similar to a single-acting ram pump. The use of diaphragm valves makes it possible for the pump to deal with liquids containing solids or semi-solids in suspension.

The drawing shows the pump on the suction stroke in which compressed air flowing past the valve *A* to the ejector *B* holds open the valve *C* by its pressure on the underside of the diaphragm *D*. Compressed air also passes into the top of the operating cylinder of the delivery valve *E*, to the chamber above the valve diaphragm *F*, and into the lower end of the operating cylinder of the suction valve *G*. The air thus holds the delivery valve *E* closed and the suction valve *G* open, whilst the compressed air passing through the ejector *B* creates a vacuum in the pump casing to draw liquid through the suction pipe. The lower end of the operating cylinder *E*, the upper end of the cylinder *G* and the chamber above the diaphragm *H* on the suction side are connected to the ejector and are also subjected to vacuum. This connection to a common vacuum not only assists in holding the respective valves in the required positions but also balances the pressures on each side of the diaphragm *H*.

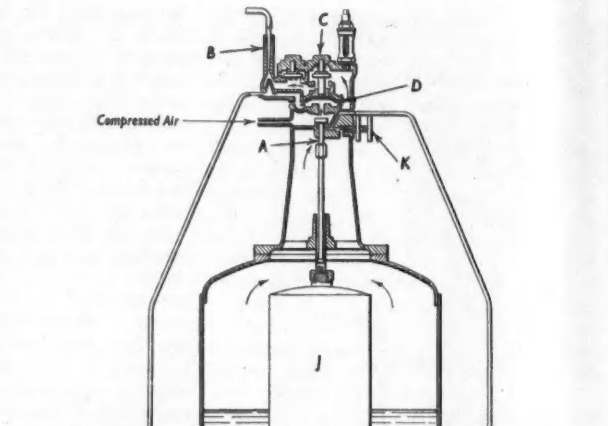

Fig. 29—Arrangement of "Ejectopump"—Gresham and Craven

When the pump casing is nearly full of

Fig. 30—"Ejectopump"—Gresham and Craven

liquid the float *J* rises to force the valve *A* up on to its seating and cut-off the air supply to the ejector and diaphragm *D*. The valve *C* is then closed by its spring and the delivery stroke begins. At this stage compressed air flows into the pump casing by way of the needle valve *K*. Connections to the front of this valve *K* also supply air under pressure to the chamber above the diaphragm *H* and the lower part of the operating cylinder *E*. At the same time the upper end of the cylinder *E*, the chamber of the diaphragm *F* and the lower end of the cylinder *G* are all vented to the atmosphere via the ejector which has been cut off from its supply of compressed air. The delivery valve *E* then opens and the suction valve *G* closes, the liquid in the casing being forced into the delivery branch by the pressure of the air above it. When the level of liquid in the casing has dropped a predetermined amount the unsupported weight of the float *J* is sufficient for it to drop and close the valve *C* for the next pumping cycle.

One of the " Ejectopumps " on the stand has been designed to facilitate cleaning. Its casing is made in two sections held together by hand-operated hinged clamps so that the upper part can be quickly released and raised to expose the whole of the interior. The new pumps are made in 3in, 4in, 6in and 9in sizes.

John I. Thornycroft and Co., Ltd.

The many and varied products displayed upon the stand of John I. Thornycroft and Co., Ltd., Thornycroft House, Smith Square, London, S.W.1, give a good impression of the firm's activities in the marine and general industrial engineering fields. Models are used to show typical vessels and boats, a funnel developed to eliminate the nuisance of the downrush of fumes and smoke on vessels, water-tube and other boilers for marine and land installations, and others of the larger units built by the firm.

Typical of the range of marine diesel engines for the smaller commercial and pleasure craft, made by the firm in powers from 20 b.h.p. to 120 b.h.p., is a four-cylinder direct injection unit developing 30 b.h.p. at 1750 r.p.m. It is of similar design to a large number of engines supplied for installation in ships' lifeboats and is fitted with a 2 to 1 reducing gear. When required for continuous heavy duty the engine can be set to run at 1200 r.p.m. to 1500 r.p.m., when it develops 20 b.h.p. to 25 b.h.p.

The engine is of straightforward design, as can be seen in Fig. 31, its crankcase and cylinders being combined in monobloc design and fitted with a detachable cylinder head carrying the valves and valve gear. A direct injection combustion chamber of toroidal shape formed in the crown of the pistons is designed to give easy starting from cold without the use of heater plugs or other aids. The forward end of the crankshaft is arranged to provide a full power take-off for various purposes. As a standard a manually operated reverse gear unit, having a multi-plate clutch for ahead drive and epicyclic gearing and a band clutch for astern, is fitted directly to the engine.

The firm's latest design of liquid fuel burner is shown fitted to a typical furnace front. This unit is fitted with a device which makes it impossible to turn on the oil to any sprayer holder from which the sprayer has been removed or is not in the correct working position.

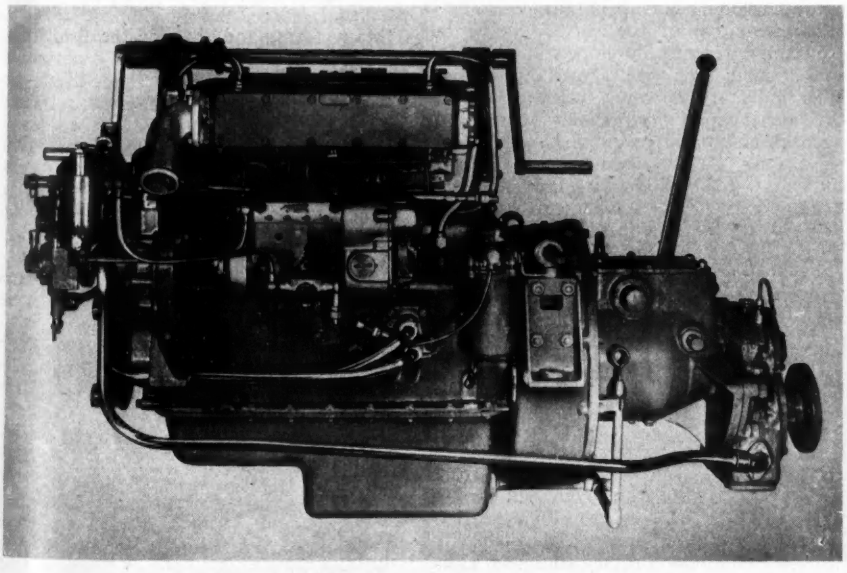

Fig. 31—30 b.h.p. Marine Engine—Thornycroft

Decca Radar, Ltd.

A simple accessory which can be used to enable the tracks of ships to be plotted directly on a radar screen is among the exhibits shown by Decca Radar, Ltd., 1–3, Brixton Road, London, S.W.9.

This equipment, which is known as the " Deccaplot," consists of a circular light alloy casting containing a partially reflecting mirror and a " Perspex " plotting surface which is edge-illuminated. The " Deccaplot " is easily fitted on the front of a Decca 12in display, and when it is in position (Fig. 32) plotting can be done without parallax error because, as indicated in Fig. 33, the reflections of the plotting marks coincide with their corresponding radar echoes, whatever the observer's viewpoint. The plotting surface, Fig. 33, is curved to match (in the opposite sense) the curvature of the P.P.I. screen. If an observer represented by O_1 places a pencil point at *A*, then the image of *A* seen by reflection will coincide with the image of the radar echo A_1 transmitted along A_1O_1 through the partially reflecting mirror. If the observer moves to O_2 the image of the pencil point *A* will still coincide with the image of the radar echo A_1. Thus the system has no parallax error.

The plotting screen is edge-illuminated so that a wax pencil mark on the plotting surface will show up on the radar picture. When the plotter lighting is switched off the pencil marks cannot be seen and the P.P.I. picture is then observed normally. The pencil marks can be removed easily by wiping with a cloth.

In Fig. 32, the plotting screen is shown fixed in position on the Decca 12in display unit. The overall dimensions of the plotter are 15⅝in diameter by 2¾in total depth, of

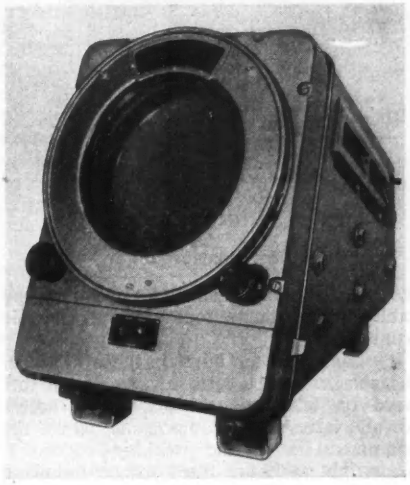

Fig. 32—Radar Plotter—Decca

which 1⅛in projects above the normal radar screen. The weight of the plotter is 7¼ lb.

An equipment which is said to be the first completely waterproof marine radar display is also being shown on the same stand. It is designed for use on an open bridge in all weather conditions. This waterproof display unit (type " 4207 ") is completely enclosed in a watertight case (Fig. 34) with panel controls extending through watertight glands to provide the same facilities as the standard Decca " 159B " installation. The unit illustrated will operate as a remote display in conjunction with an

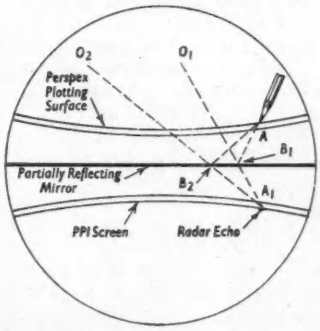

Fig. 33—Principle of Radar Plotter—Decca

existing Decca installation ; alternatively, it can be supplied to operate as the master display controlling the complete installation. The only additional equipment required when adding the waterproof display to an existing installation as a remote display is the Decca radar power pack " 169." The additional controls required for master display use, as provided on the " 159B " radar, are housed in a separate control box, which fits under the front panel and becomes an integral part of the equipment.

The waterproof display is housed in a cast aluminium alloy case, which is finned for radiation cooling and is finished matt black and dull chrome. All electrical connections to the rest of the equipment are

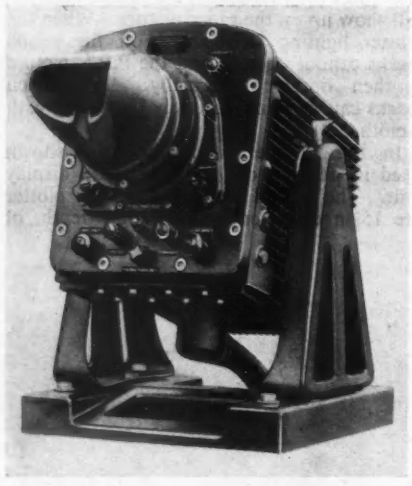

Fig. 34—Radar Waterproof Display—Decca

reached from the back and the connecting cables are brought out through flexible trunking.

By slackening ten bolts on the front panel the chassis can be released and drawn forward on telescopic runners, giving access to all valves and components while the equipment is in the working condition. Watertight seals are fitted to the following controls: brilliance, focus, vertical and horizontal, shifts, range switch, bearing cursor, heading marker (coarse and fine), calibration rings (dimmer and "off"), veering scale illumination (dimmer and off). All these controls can be operated independently of the master display.

The additional control box, which is supplied when this display is to be used as the master, contains the following controls:—anticlutter (rain), anticlutter (sea), gain, tuning meter and switch, tuning, standby switch, and radar "on/off" switch.

Mirrlees (Engineers), Ltd.

On the stand of Mirrlees (Engineers), Ltd., Hillington, Glasgow, S.W.2, there is shown a group of "Imo" pumps of different capacities for forced lubrication, fuel oil transfer and other duties. The general design of these pumps is now fairly familiar; they have within the body three screws consisting of a central power rotor and two side or idler rotors, which rotate in three parallel bores of a sleeve. The thread surfaces of the screws are so shaped that they form a tight seal both in relation to each other and to the sleeve. As the screws rotate the seal formed by the threads moves axially and uniformly to act as a piston moving continuously in one direction. The screws are the only moving parts of a pump and the design is such that all the bearing surfaces are lubricated by the liquid pumped.

One of the pumps exhibited is arranged for bulkhead mounting and is capable of delivering 21 gallons per minute of boiler fuel oil against a total head of 320 lb per square inch when running at 1750 r.p.m. One of the smaller pumps, that illustrated in Fig. 35, is used for handling oil over a wide range of duties. When driven at 2900 r.p.m. it can deliver 16 g.p.m. of lubricating oil against a head of 250 lb per square inch.

Keelavite Rotary Pumps and Motors, Ltd.

The hydraulic equipment upon the stand of Keelavite Rotary Pumps and Motors, Ltd., of Allesley, Coventry, includes a new 10 cubic inch gear unit designed to operate as a hydraulic pump or motor in either direction without need for modification. This unit, to be seen in Fig. 36, incorporates a hydraulic balancing system which eliminates the need for fitting rubbing plates and prevents radial or axial displacement of the gears.

The pump has a maximum continuous working pressure of 2000 lb per square inch and with it overall efficiencies in excess of 85 per cent are stated to have been maintained

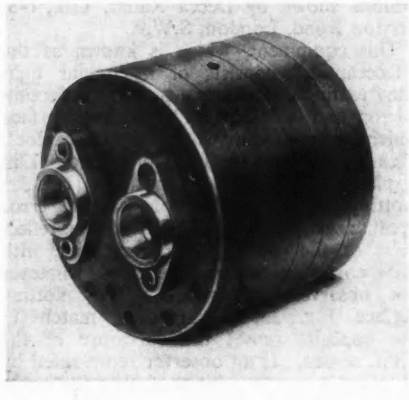

Fig. 36—Hydraulic Pump or Motor Unit—Keelavite

after prolonged periods of heavy duty operation. Working as a pump at 2000 lb per square inch the unit develops 75 h.p. at 1500 r.p.m., and its peak working speed is 3000 r.p.m. The unit is only 11·5in diameter by 12in long. A working model on the stand shows the new unit in operation as a hydraulic motor developing 2·5 h.p. at 50 r.p.m.

Representative of the smaller range of gear pumps recently developed by the firm is a 3 cubic inch unit shown in section. Other units of 1·5 cubic inches and 4·25 cubic inches capacity respectively are identical in construction and operation, and can be used as pumps or motors. The two smaller of these units operate at a pressure of 1500 lb per square inch and the larger one at 1000 lb per square inch, the maximum speed rating being 3000 r.p.m.

Among other exhibits displayed are hydraulic cylinders, which are made in five bore sizes from 2in to 6in with strokes up to 130in; fixed and variable capacity rotary abutment units for operation as hydraulic pumps or motors suitable for pressures up to 1500 lb per square inch; gear pumps and motors for pressures up to 2000 lb per square inch; and a selection of valves.

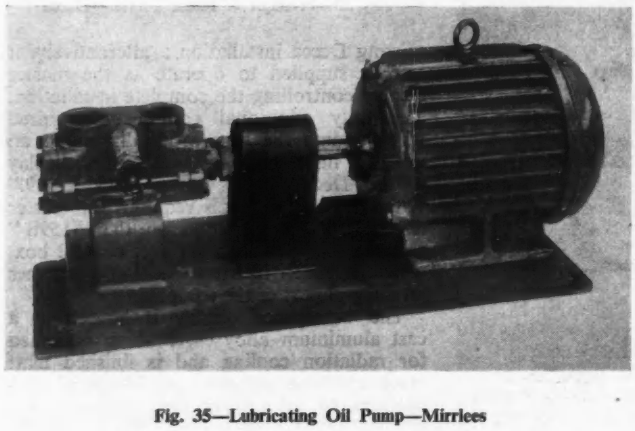

Fig. 35—Lubricating Oil Pump—Mirrlees

Saunders Valve Company, Ltd.

A new addition to the range of "Safran" centrifugal pumps, made by the Saunders Valve Company, Ltd., Cwmbran, Mon, is a centrifugal cooling water circulating pump for marine engines, which is a self-priming, two-stage unit with uniform performance for both directions of rotation. A built-in pressure-operated diaphragm valve provides a means of automatic hydraulic control of pressures and stages in the pump.

These pumps, one of which can be seen in Fig. 37, are designed for bolting directly to an engine, the shaft being gear driven in the crankcase and the bearings lubricated from the engine system. Once the casing is filled with water the pump is self-priming. Any air present on starting is drawn from the suction pipe by a priming jet and in a short period normal pumping begins. A flap valve fitted in the suction passage ensures retention of sufficient water in the casing for subsequent self-priming.

When the engine is revolving in the lower speed range the pump operates as a two-stage unit, the water passing from the first impeller to the second impeller, via a cross-over passage in which is situated the diaphragm valve, and finally discharges through a non-return port into the main pressure chamber of the pump. As engine speed is increased pressure generated by the pump also increases. To prevent this pressure becoming excessive with consequent waste of power, the diaphragm valve is subjected to pressure from a spring-loaded primary valve mounted on top of the pump casing. This valve gradually closes the diaphragm in the cross-over passage, and when closure is complete the pump operates as a single stage unit with water discharging through a second non-return port into the pressure chamber.

With engine speed falling a reversal of the sequence of operations takes place until the pump reverts to two-stage action at low speeds. In the primary valve a spring-loaded piston, seating against the pressure within the pump casing, is set to a predetermined load to control the hydraulic pressure actuating the main control diaphragm valve. When the piston valve returns to its closed position the primary valve actuating water is by-passed through a relief pipe to the suction passage.

Many forms and sizes of the firm's dia-

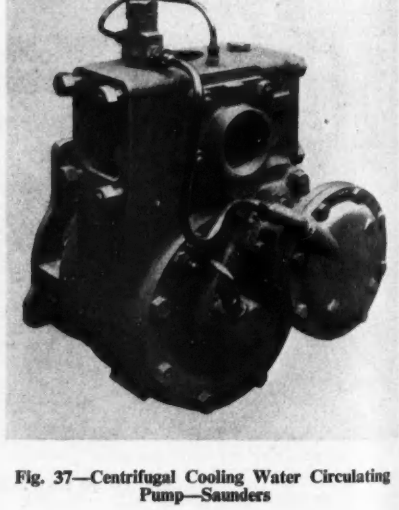

Fig. 37—Centrifugal Cooling Water Circulating Pump—Saunders

phragm valves are shown, including the new units made with a body, bonnet and handwheel of ebonite for use where corrosive liquids are handled.

Kestner Evaporator and Engineering Company, Ltd.

Some typical examples of the very wide range of chemical plant made by Kestner Evaporator and Engineering Company, Ltd., 5, Grosvenor Gardens, London, S.W.1, is being shown by means of models and photographs of spray driers, high-temperature oil-heated plant, evaporators, thermo-venturi

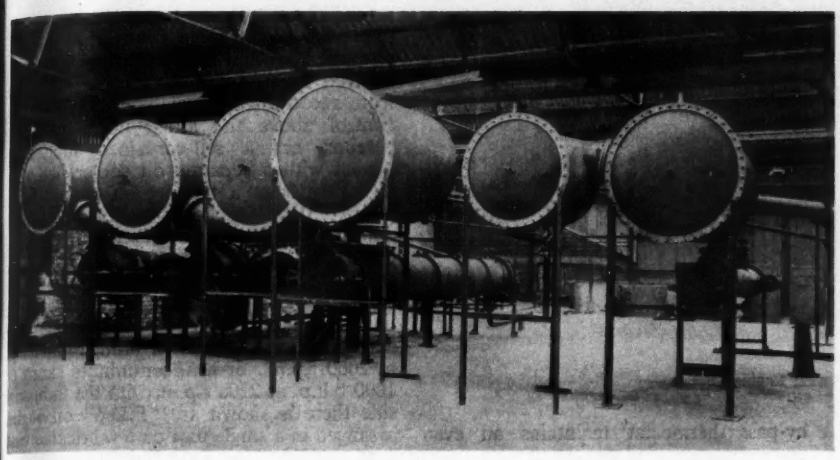

Fig. 38—Multi-Circulation Evaporator Assembled in Works—Kestner

flash driers, pickling plant and recovery plant, &c. Smaller items of plant, such as fans, pumps, stirrers, gas scrubbing equipment, pipe fittings, &c., are also shown on the firm's stand.

As a matter of interest we reproduce in Fig. 38 one of the plant photographs shown by the firm of one of its "triple-effect, climbing-film" vacuum evaporators, followed by a single-effect, forced-circulation finisher, assembled on its side in the works before despatch. This plant was supplied to a firm in South Africa and it was constructed with all of its vapour and liquor contact parts in copper because of the acidic nature of the liquor being handled. This liquor is distillery slop resulting from fermentation of molasses for the manufacture of acetone and butanol by fermentation. The plant was erected in the open, the only shelter needed being a small hut for the protection of the control instruments.

In this firm's multi-circulation, high-vacuum evaporators the liquor is not evaporated in a single pass but is caused to flow through two or more evaporating passages or calandrias arranged in series, each being a climbing-film evaporator with tangential separator. A relatively small number of long evaporating tubes are used in each calandria, the liquor rising through the tubes at high velocity in the form of a film on the tube walls. This liquor discharges at the top of the tubes directly into the separator, from which the vapour is drawn off and the partly concentrated liquor returned by gravity to the inlet of the next calandria in series. The vapours leaving each separator enter a common main connected to the condensing plant. With this arrangement the whole plant operates at the full vacuum produced by the condensing plant and evaporation takes place at a minimum temperature in each pass.

In a typical multi-circulation evaporator there would be two or more calandrias, the most common being the triple-circulation design with three calandrias. These calandrias are formed by dividing a single steam shell into three sections or nests of tubes, each nest having progressively fewer tubes than that preceding. The flow of liquor is directed into the separator at each pass and separated from adjacent sections by flow boxes at the top and bottom of the steam shell.

Butterley Company, Ltd.

A compact oxygen generating plant which it is manufacturing under licence in this country is one of the exhibits on the stand of the Butterley Company, Ltd., of Ripley, near Derby. These generators can be used either to charge cylinders or to feed a works pipelines by way of a storage bank, which is introduced to smooth out fluctuating demands. They are made in fourteen standard sizes to produce moisture-free, 99·5 per cent pure oxygen, compressed normally to 2000 lb per square inch, at rates from 300 to 12,000 cubic feet per hour. In the smaller sizes the generating plants consist of three units and in the larger sizes four units. The larger models are also capable of producing simultaneously with oxygen, dry nitrogen of 99·9 per cent purity, and with a simple modification crude dry argon. The smaller sizes can be used to produce 99·5 per cent purity nitrogen, but not simultaneously with oxygen. One of the generators is shown in Fig. 39.

In the smaller models a multi-stage low-speed air compressor supplies air to a purifier in the first stage of compression. In this purifier carbon dioxide is removed—an essential factor in the separation of air otherwise the plant would freeze up and render the separation process impossible. In the subsequent air separation unit, drying, cooling, liquefaction and distillation take place. A liquid oxygen pump in this unit delivers pure oxygen or nitrogen at any desired pressure up to 180 atmospheres.

The larger plants have the air drier built as a separate unit, and in the air separation unit together with an expansion engine, cooling, liquefaction and distillation are carried out.

A power press from the firm's range of sheet metal working plant is also exhibited, and part of the stand floor is laid with the iron paving tiles supplied for use where heavy wear takes place in industrial establishments. Other aspects of the firm's activities are shown by means of photographs of constructional steelwork, cranes, wagons, &c.

Fodens, Ltd.

The group of marine oil engines shown upon the stand of Fodens, Ltd., Sandbach, Cheshire, includes two models of the "F.D.6" six-cylinder, two-stroke unit, which is based upon the design of the firm's road transport engines. This engine, with a bore of 85mm and a stroke of 120mm, has an intermittent rating of 120 b.h.p. at 2000 r.p.m., a continuous rating of 102 b.h.p. at 1800 r.p.m., and when used for heavy duty, 75 b.h.p. at

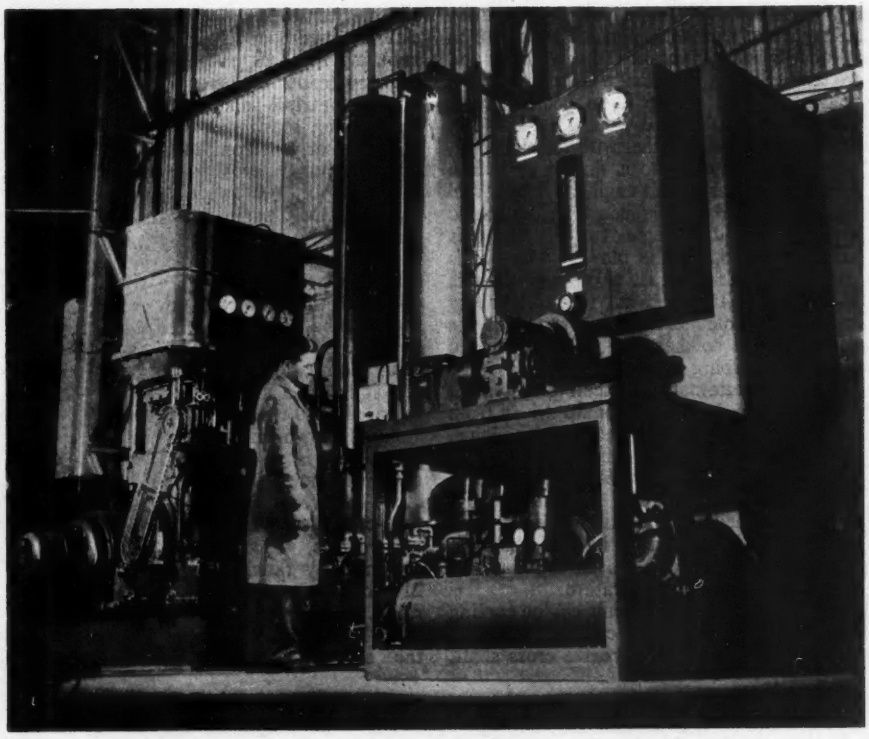

Fig. 39—Oxygen Generator—Butterley

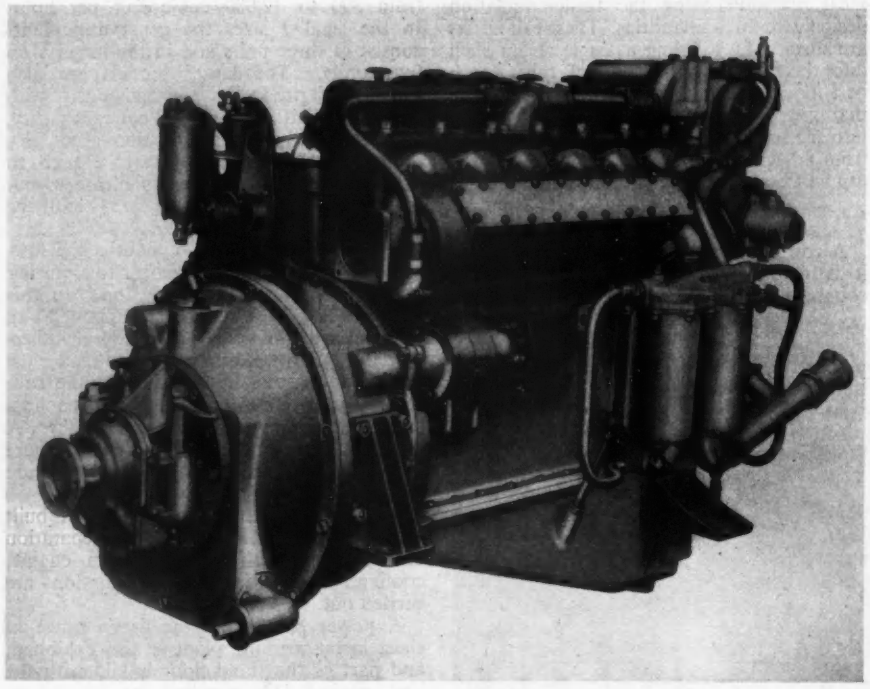

Fig. 40—Six-Cylinder Marine Engine—Foden

1500 r.p.m. Its major components are similar to those used in the road vehicle engines.

The design is based upon the Kadenacy principle of supercharged two-cycle compression ignition. A common air chest is fed with air by a low-pressure Roots blower, and from this chest the air is delivered to the cylinders through ports in the liners, which are specially designed to impart a high degree of swirl to the air. The exhaust is scavenged through valves in the cylinder heads, and these valves are operated by rockers and short push rods from a camshaft set high in the cylinder block.

The general construction of the engine is compact and robust, the crankcase and cylinder block being a single aluminium alloy casting fitted with wet liners. Two cast iron cylinder heads each cover three cylinders and are secured to the crankcase by long through bolts extending to the main bearing caps. The blower is designed as an integral part of the engine and together with the camshaft, fuel pump and dynamo is driven by helical gears at the rear of the engine. A unit fuel pump complete with built-in filter, hydraulic governor and diaphragm fuel-lift pump is mounted on top of the blower, where it is readily accessible, whilst a primary filter is carried on the timing case. Injectors having single large hole nozzles are carried in the cylinder heads so that they can be removed without disturbing the rocker boxes.

The fully automatic lubricating system of the engine is fed by a gear pump driven from a cross shaft at the forward end of the engine. Cooling is effected by a tube and shell heat exchanger, through the tubes of which sea-water is passed from the sea-water pump. A spring-loaded by-pass valve prevents excessive pressure occurring in the exchanger in cold weather and helps to maintain an even lubricating oil temperature.

A fresh water closed circuit engine cooling system has a centrifugal circulating pump, driven from the oil pump drive cross shaft. A by-pass thermostat maintains an even water temperature and rapid warming up is assisted by the inclusion of the exhaust manifold cooling in the closed circuit of the fresh water system. The Serck combined lubricating oil and fresh water heat exchangers are carried in a cast aluminium header tank which provides the necessary volume of fresh water. The tube stacks are interchangeable and can be removed for cleaning without dismantling the heat exchanger header tanks. A Megator triple-shoe, self-priming sea-water pump is driven from the oil pump cross shaft.

The "F.D.6" engine illustrated in Fig. 40, which is exhibited, is fitted with a two-to-one reduction reversing gearbox, supplied by the Self Changing Gear Company, Ltd., and it is rated at 105 b.h.p. at 1800 r.p.m.

Also shown upon the stand is one of the firm's new "F.D. 12," twelve-cylinder, twin-crankshaft marine engines, which is continuously rated at 210 b.h.p. at 1800 r.p.m. This engine (Fig. 41) is based upon the six-cylinder unit and some 95 per cent of its parts including th banks of six cylinders are common t both models. It consists of two engine arranged as a single unit and drivin through a common gearbox. This engine ha an intermittent rating of 240 b.h.p. at 200 r.p.m. and a fifteen-minute rating of 30 b.h.p. at 2200 r.p.m.

As with the six-cylinder engine, for direc drive applications a light, compact, self change design of gearbox is fitted, whilst fo cases where a reduction gear is required heavier box is employed. When this heav box is fitted reductions of 2–1, 3–1 or 4– together with alternative direction of rotation are available. Single lever control can b provided with either box. Through thes boxes the engine speed control is hydraulic ally operated and interlocked with the gea control, so that it is impossible to chang from ahead to astern running with the spee control above the idling position. Eac gearbox has a self-contained lubricatin system with a separate oil cooler, fed wit sea-water from a tapping on the sea-wate pump outlet. This flow (7 gallons per minut approximately) can be used for exhaus cooling by injection if required.

Another marine engine of the same ligh robust design on the stand is a four-cylinde unit continuously rated at 70 b.h.p. at 180 r.p.m. and with a one-hour rating of 80 b.h.p at 2000 r.p.m., or a fifteen-minute rating o 1000 b.h.p. at 2200 r.p.m. On the industria side there is shown an "F.D.6" oil engin arranged in a single unit on a fabricated bas with a 60kW d.c. generator and complet with radiator cooling and switchgear, &c

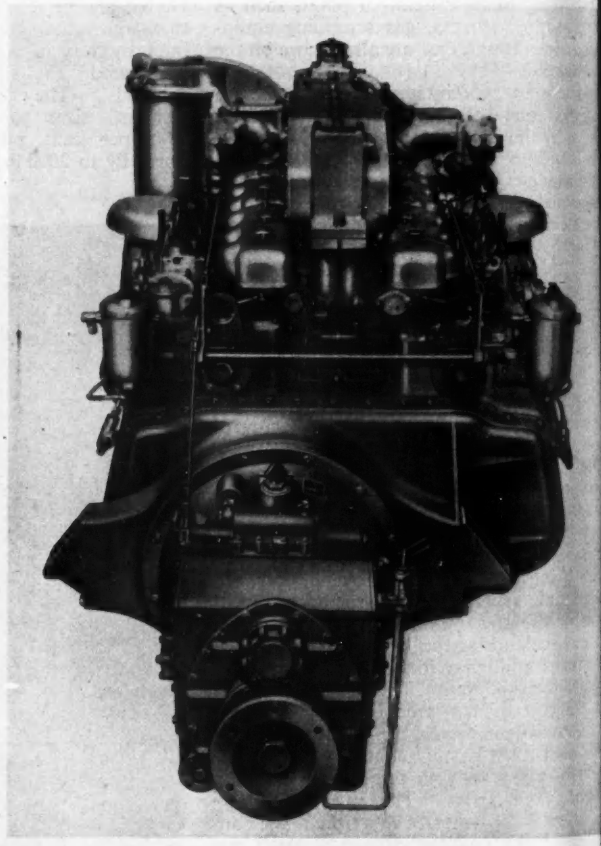

Fig. 41—Twelve-Cylinder Marine Engine—Foden

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